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DEVELOPMENT IN EAST AFRICA

THE report of the Royal Commission on East Africa*, appointed in January 1953, with Sir Hugh Dow as chairman, to examine the measures necessary to achieve an improved standard of living, including the introduction of capital to enable peasant farming to develop and expand production, is a massive document of nearly five hundred pages and ranges over a distinctly wider field than its strict terms of reference cover. The Commission was indeed charged to examine, and where necessary comment upon, policy in such related fields as education and public health which appeared to it to bear on the problems with which it was primarily concerned, and in particular the extent to which existing technical training facilities are adequate to meet the requirements of extensive industrial development. It was also to consider probable trends of population in East Africa and to make appropriate recommendations in relation to the other problems involved. Specifically, it was instructed to frame recommendations with particular reference to six topics: the economic development of the land already in occupation by the introduction of better farming methods; the adaptations or modifications in traditional tribal systems of tenure necessary for the full development of the land; the opening for cultivation and settlement of land at present not fully used; the development and siting of industrial activities; conditions of employment in industry, commerce, mining and plantation agriculture with special reference to social conditions and the growth of large urban populations; and the social problems which arise from the growth of permanent urban and industrial populations.

Even without the broad interpretation of its terms of reference—including some study of the historical background, of the results of past legislative and administrative measures, and an attempt to understand how East Africa's modern environment has arisen—which the Commission has wisely chosen to adopt, the report deals largely with details which lie outside the field of science and even of technology, though they are of indirect interest to both scientist and technologist and may determine the success or failure of his work in Africa. Nevertheless, in its considered unprejudiced approach, even more than in its comprehensive grasp and constructive uninhibited suggestions, the report is characterized essentially by the scientific spirit. Its whole approach and treatment of the problems are in keeping with the late General Smuts's plea for the cool, serious, gentle spirit of science in world affairs in his Sidgwick Memorial Lecture at Cambridge more than a quarter of a century ago, though in that interval neither the scientific expert nor the scientific spirit has won the place and influence which Smuts considered necessary in a truly democratic order.

For that reason alone although, apart from some points in the chapters on manufacturing industries and on African labour, particularly relating to technical education, the chapters on health and education, water development, statistics, agricultural potential and alternatives to customary land use contain most of the material of immediate concern to the scientific worker; the main conclusions and the recommendations and suggestions collected at the end, numbering nearly five hundred, will be read with interest by all men of science concerned with African problems. Not only do they confirm important findings of the recent Binns report on education and of Dr. E. B. Worthington's survey of research and scientific services in East Africa, but they also provide background for the consideration of work being carried out by the Colonial Research Council, or with the assistance of Colonial Development and Welfare Funds or Technical Aid. They indicate how large a contribution science can make to African development and welfare, and indeed that, without such assistance and a scientific approach to many of the problems involved, these problems are unlikely to be solved.

The Commission does not over-simplify the issues or disguise its belief that many of the problems it was called upon to examine are highly complex. It agrees with Sir Philip Mitchell's description of them as "complex and recalcitrant". Nevertheless, its main message can be stated quite briefly. Throughout most of East Africa agricultural development is impeded on the physical side by inadequate or unreliable rainfall, by soil deficiencies and by the scourge of the tsetse fly; and on present knowledge there are few of the exploitable mineral resources which have contributed so largely to the greater national incomes of some other African territories. The economic development and prosperity of the local populations thus depend in the main on the capital and knowledge which are brought to bear upon the limited natural resources rather than upon the persistent bounty of Nature.

Moreover, while the capital, knowledge and enterprise mainly responsible for economic expansion in East Africa have come almost entirely from outside the territories, the majority of Africans are still ill-equipped to face the complex problems confronting a people so recently brought into intimate contact with Western civilization; and in particular they are handicapped by their traditional form of society, which has sought its security and stability in a mode of life that has had little specialization on the side of production, few opportunities for the exchange of goods and few human contacts with the outside world. Those responsible for policy in East Africa have always been alive to the importance of introducing the capital, organizing ability and technical skill which progress requires. They have also been alive to the economic weakness of the African when confronted by enterprising forces emanating from more developed regions, and as part of a policy designed to safeguard and protect the indigenous populations a land policy has been introduced which preserves the customary rights in land that the

* East Africa Royal Commission 1953–55 Report. (Cmd. 9475.) Pp. xiv+482+4 maps. (London: H.M.S.O., 1955.) 17s. 6d. net.

African has enjoyed; in other directions, too, endeavours have been made to insulate the African from rigorous external competition.

This policy, however, conflicts with the desire to create the new income which alone can make possible a rise in African living standards; and the combined effect of a strong resistance to change on the part of the African, modified by an increasing desire to participate in the advantages derived from the ideas and practices of the modern world, and of a strong protective urge in official policy, has been to create a network of restrictions and controls which impede the progress it is sought to attain. All communities in East Africa face an apparent choice between progress and security; but there is no real security in the institutions which now seem to offer it. What is required, the Commission finds, is to create conditions favourable to the exercise of those activities which make for progress, and to substitute for policies hindering change other policies which will facilitate those modifications of traditional African society that will enable the requirements of the modern economy to be met.

In examining the population problem, the Commission accordingly focused attention on the conditions under which the African may participate in the advantages that a modern society has to offer, concentrating on the possibility of raising income per head of population in an environment which perhaps offers more discouragements than assistance. There are no short cuts, and there is no escape from the necessity to transform the traditional methods of production and exchange if the desired result is to be achieved. The Commission never flinches from facing difficulties; if at times it may appear to be looking too far ahead, the imagination and vision of the report are unmistakable, and the real issues are laid bare. Whatever reservations may be made as to timing, the essential soundness and value of the Commission's ideas and practical suggestions are unmistakable, and they are presented with a courage and clarity that should commend them to the many scientific workers and technologists who will be called upon to play their part in implementing them.

Fundamentally, the creation of larger incomes per head of population means greater emphasis on specialized production and greater facilities for the exchange of goods and services, as well as a greater mobility of economic resources, so that new forms of production become possible. It means greater access to supplies of new capital and the acquisition of new skills and new knowledge; but the Commission points out that the essential pre-requisite for creating an effective African labour force is the stabilization of African labour and the severance of its ties with the reserves. The key to a permanent rise in the supply price of African labour is to foster an increase in the incomes of the peasants, whether they produce for their own subsistence or for the market. Moreover, while the Commission believes that African labour can be trained to a considerable level of proficiency, the low productivity of ordinary African labour is not due merely to the lack of technical skill but also to such factors as under-nourishment, poor physique, endemic disease, inadequate supervision and a lack of interest in ordinary economic incentives.

If these conditions can be fulfilled, the fear of over-population which dominates so much of the contemporary debate may well prove to be illusory; but their fulfilment will demand not only courage but also a degree of open-mindedness and the readiness to put the general interest in front of sectional interests that, from the Commission's comments on such diverse matters as economic development, transport, statistics and research, has often been conspicuously absent. In particular, a re-examination of the whole system of restriction and controls which dominates the distributive system is called for, with the view of discarding those administrative devices which serve only to perpetuate an obsolete conception of self-sufficiency or to promote a sectional interest. Moreover, whether in the field of education, in the supply of credit facilities or in the acquisition of technical skill, the expenditure of resources in providing such aids should be concentrated where they are likely to be most effective; and there should not be undue disappointment if positive results are slow to appear.

While the Commission thinks that a stage has now been reached when a more direct contribution from the African to the development of East Africa is both possible and desirable, it does not believe that any appreciable amount of capital for new industrial development can conveniently be raised from the African population through compulsory saving without imposing unreasonable burdens or doing damage to African enterprise and production. No large reservoir of investable resources for rapid industrialization or for investment in new social capital exists in East Africa, and any substantial amount of new industrial development will depend on the production of increased income from the land. The economy cannot afford to provide large and effective inducements to encourage any large-scale promotion of new enterprise from abroad, and public expenditure on development projects should be concentrated on objects likely to yield immediate and reasonably certain results in the form of increased income, so that there will be a larger surplus to devote to projects which take longer to mature. It is important that the public expenditures of the territories should be closely geared to their respective national incomes.

Such considerations imply that land policy must be directed towards the removal of those conditions which prevent the available land from being effectively utilized and equally towards the creation of conditions which will facilitate the application of technical knowledge, labour and capital in proportions suitable over the long period to the generation of maximum income; what may be called individual rights of land tenure must replace the existing tribal controls. It is from this point of view that the Colonial development and welfare schemes for East Africa, including research schemes, educational policy, and the specific scientific problems of agriculture, forestry, hydrology and the like, should be considered.

"One of the most useful roles for statistical analysis," wrote Prof. Ely Devons, in *Lloyds Bank Review* last year, "is to reveal the implications, and frequently the consistencies in policy decisions and so attempt to ensure that the main lines of policy are in harmony and not in conflict." Much in the present report of the Royal Commission admirably illustrates that thesis, and the main argument of the chapter on statistics, with its strong plea for adequate support for the East African Statistical Department, is that some of the political and administrative problems have now become so urgent that policies formulated on the basis of inaccurate data, or on the general impressions of observers with different standards of reliability, may, at the best, be ineffective and, at the worst, dangerous, and that the regular collection and publication of statistical data are one means of reducing or avoiding these dangers. While, however, it is of the utmost importance that the exceedingly limited resources of East Africa should be employed in the most effective manner, the resources at the disposal of the East African Statistical Department, alike in finance and qualified personnel, are inadequate for the proper discharge of the duties and responsibilities assigned to it, notwithstanding that its work is efficiently conducted.

Nor is this all. These limitations are intensified by the unsatisfactory and uncertain relationship existing between the Department and the Territorial Governments. While the East African Statistical Department is the most technically qualified official agency in the field of statistics in East Africa, and additional expenditure on the Department would yield far greater benefits if devoted to the Department than if spread over three territorial departments, the Department is so restricted that initiative for any improvement in the statistical services has to come from the Territorial Governments. Of this position the Commission is severely critical, and suggests re-examination of the position by the three governments and by the High Commission. The suggestion that the three Territorial Governments should be encouraged to build up independent statistical services is firmly rejected, and the Commission insists that it is primarily the relationship between the Department and the Territorial Governments which requires clarification. It is suggested also that the East African Statistical Department should receive a grant from Colonial Development and Welfare Funds for the development of its statistical and research work, in addition to the financial support provided by the Territorial Governments, and that the funds from both sources should be provided in accordance with a scheme covering several years at a time.

This is not the only point on which the Royal Commission is critical of the Territorial Governments or of the East Africa High Commission. Elsewhere, asserting that economic policy must be based on the assessment of economic potentialities in the territories and of East Africa as a whole, it says that development must not be impeded by policies of economic self-sufficiency within the three territories. In place of the present East African Railways and Harbours Administration, tied to the political exigencies of the separate Territorial Governments, it recommends reconstitution of the Administration as an independent autonomous Railway and Harbours Corporation, the share capital of which should be owned by the three governments, but which would be empowered to determine its rates and charges and operate and develop as a financially independent concern. It suggests, further, the establishment of a Colonial Transport Development Fund to finance the construction of railways, roads and the inauguration of air services.

These recommendations are intended to divorce railway finance, management and operation from political considerations and from uneconomic territorial rivalries which undermine the viability of the system as a whole. Similarly, the Commission recommends the establishment of an East African Road Corporation, financed jointly by the East African Governments and by loans from the Colonial Transport Development Fund and managed as an autonomous body under the High Commission. Again, while in regard to the discovery and development of water supplies, lack of which throughout East Africa is the major factor in preventing the use of otherwise productive resources, the Commission is concerned chiefly to secure adequate co-ordination within each territory, it insists that the hydrological research required should be carried out under the ægis of the East African Agriculture and Forestry Research Organization.

This would involve the water department in each territory—concerning the organization and staffing of which specific recommendations are made—working in close touch with the High Commission, the body to which the East African Agriculture and Forestry Research Organization is responsible; elsewhere in the report, the Royal Commission is rather critical of some aspects of the present research organization. The major technical obstacles to agricultural development and the economic use of land are the lack of basic data and information, the absence of co-ordination in research, and finance. While the Commission found that much effort was expended on research directed towards the solution of the many problems posed by the harsh environment and towards the evolution of methods for the more economic use of available natural resources, it noted a tendency for research to be conducted in water-tight compartments, and a general lack of liaison and exchange of valuable experience. Our knowledge of East African soils is still rudimentary, correct systems of usage have still to be evolved for various types of vegetation regimes and adequate hydrographical data are an essential pre-requisite to the irrigation projects which East Africa urgently needs. Moreover, the areas of high potentiality are very unequally distributed, and in the absence of a regional approach the tempo of development will be retarded in all the territories at a time when it is imperative to accelerate the process.

While the Commission thus expects important help towards the discovery of better systems of land usage from research, it found great need for a regular sequence of experiment from research plot to pilot field-unit, to representative test-area, and then to

rehabilitation and development plan, so as to determine the patterns of usage most suitable for each locality. Impressive examples are cited of opportunities for an attack with the resources of the East African Agriculture and Forestry Research Organization on problems quite beyond the limited resources of a district team. The Commission points out, however, that there is some risk that the centrifugal political force which pulls the three territories apart at present will leave the Research Organization too weak financially and too remote administratively to make its full contribution. There is no alternative basic research station, and the budgeting vote for the Organization is subject to considerable risk in the legislatures, where few appreciate the importance of basic research or the necessity of re-examining under tropical conditions knowledge obtained in temperate climes.

While recognizing this danger, the Royal Commission sees no solution in the separate financing of the Research Organization from Colonial Development and Welfare Funds, but looks to a better relation between the central research institute and the territorial departments when the legislatures and technical staffs are united in a clear view of the objectives. To assist this process, it suggests that the staff of the East African Agriculture and Forestry Research Organization should be strengthened so that it can make available for travel in the territories scientific workers free from basic research responsibilities, who can specialize in bringing the Organization's findings to particular local problems. Within each territory there should be a special liaison research officer responsible for seeing that there is a continuous progress from research to development. It is also suggested that one of the first requirements of the East African territories is a district-by-district survey which will describe in factual terms the available land, the topography, the soil, rainfall, population and means of communication of the districts; the Commission recommends the initiation, as soon as circumstances permit, of a detailed ecological survey indicating the kind of agricultural specialization, the appropriate kind of farming system and the suitability of different types of farm organization.

There are other points of scientific interest in the report which cannot be mentioned here. The foregoing will, however, illustrate sufficiently the scientific and objective approach of the Royal Commission to the problem of development and welfare in East Africa, its receptivity to new ideas and the firmness and courage with which it challenges customs, vested interests, practices and privileges which lead to wasted resources or are anti-social in their effects. It will be apparent how closely its findings bear on the effectiveness of research already being conducted in the region and on proposals for technical assistance or Colonial development and welfare. It is a challenge to promote co-operation and understanding between races as well as between Governments, between scientific workers and legislators as well as between industrialists and settlers; it is also a challenge to the goodwill required to implement the rigorous reforms advocated by the Commission.

FOOD PRODUCTION IN SOUTH AFRICA

A Survey of the Food and Feed Resources of the Union of South Africa

By G. Van de Wall and E. D. Alvord, Jnr. (Pretoria: J. L. van Schaik, Ltd.) 31*s.* 6*d.*

AMONG the many difficult problems in the Union of South Africa, one of the most important is that of food production. The population is expanding: in 1951 it was ten millions as against five millions in 1918; with the further development of mining and other industries, further expansion seems inevitable. By Western European standards the country is sparsely populated, the density being only twenty-one per square mile compared with more than three hundred in India; it has a large farming population, nevertheless it is barely self-supporting in food. The year-books of South Africa give considerable information about crop production in the Union and the reserves, and the Food and Agriculture Organization of the United Nations has in its food balance sheets tabulated the available quantities of human food both home-produced and imported. The present survey is the most complete yet published, giving not only more detail but also providing for the first time a reasoned estimate of the output of animal food, and therefore ultimately of human food, from the veld. The period covered was from 1917–18 to 1946–47. It was apparently impracticable to bring the survey up to date; but it serves the invaluable purpose of constituting a reliable standard with which later surveys may be compared.

The first part of the survey, by E. D. Alvord, deals with livestock and their products. As the veld contributes some 90 per cent of the nutrients available to the animals, their numbers are limited by its productiveness, which in turn depends to a considerable extent on the management. During the period investigated, the average rate of stocking on the European farms was about fifteen acres per mature beast, the range being from more than twenty on the Karroo to between six and ten in the semi-arid regions, and less where the rainfall was higher. But the management is faulty; considerable quantities of digestible protein and other nutrients are not used but are destroyed in the periodic burnings. A mere increase in the density of stocking would not solve the problems because of difficulties associated with the long dry season; better management and closer linkage with arable husbandry are recommended as the way out of the difficulty.

The arable land is much more productive; it constitutes only about 10 per cent of the land area of the Union yet it contributes more to the national food supply than the 90 per cent of veld. But more could be achieved: the yields are lower than in other countries and the author courageously attributes much of this to inefficiency on the part of the farmers. Sugar-cane is the one exception: it is "the only agricultural crop which is produced efficiently in South Africa at present". But it is practically confined to Natal.

The second part of the Survey is by Dr. Van de Wall and deals with the utilization of food-stuffs and especially the consumption by human beings. Estimates of total production and of total quantities available for consumption show that while the total requirements of protein and of carbohydrates were covered there were overall deficiencies of some

17 per cent in supplies of calories, 40 per cent in those of fats, and 13 per cent in those of animal protein. The dietary of the European population, who form about 20 per cent of the whole, is considerably better than that of the 80 per cent non-European, and the author feels justified in assuming that these carry all the deficiencies, making their dietary worse than the above figures indicate.

As in the first section, the facts are fearlessly faced, and the author discusses possible improvements. The deficiency of fats and of animal protein can be met only by increasing the output of livestock products. It seems remarkable that a pastoral country like South Africa should produce insufficient meat for its rather sparse population.

The authors are to be congratulated on a very useful piece of work which will not only be invaluable to later investigators of agricultural economics but also gives clear indications to the agricultural staff as to the directions in which improvements should be made. Earlier workers, I. B. Pole Evans, P. J. du Toit, T. D. Hall, D. Meredith and others, have long emphasized the need for better management of the veld and the livestock; this survey raises the question again in such clear perspective that it can scarcely fail to receive attention.

E. John Russell

JUVENILE DELINQUENTS IN THEIR URBAN SETTING

Growing Up in the City

A Study of Juvenile Delinquency in an Urban Neighbourhood. By John Barron Mays. (Social Research Series.) Pp. ix+216. (Liverpool: University Press of Liverpool, 1954.) 17*s.* 6*d.*

It has long been known that in many cities certain unfavourable characteristics combine to produce what have been rather inelegantly termed 'delinquency-producing areas'. The author of this book, J. B. Mays, gives a warm and interesting description of one such as these, by the Liverpool docks, which he has come to know and understand through many years of work with the young people of the neighbourhood.

It is good to see a book which, as Prof. R. M. Titmuss writes in an eloquent preface, ". . . leads us to think more about boys and boyhood in a particular situation and less about delinquent boys in a social vacuum. . . . Such behaviour is for the majority of these boys not so much a manifestation of individual maladjustment but is part of the total process of adjustment to a subculture in conflict with the culture of society as a whole". In principle, such a book would be welcomed in order to redress the balance which, of late, has tended to favour clinical studies of small groups of individual, apprehended delinquents. Like myself, Mays believes the issue of detection to be irrelevant to the problem of delinquency; most of his sample of eighty boys have passed through a delinquent phase, though they were rarely caught, and they do not seem to be neurotic, psychopathic or mentally defective, in his judgment.

Yet the author has not used fully this opportunity to improve on the work of the early Chicago ecologists. The emphasis throughout is on the social setting, rather than on the 'under the roof' culture, on environmental treatment and anti-delinquency services rather than on family problems. This is not merely a question of emphasis. Given the fact that a delinquency-producing area exists, what are the influences which determine whether or not an adolescent will take part in delinquent activities? And how can we account for those youngsters who do not 'grow out of it', and who become the 'hardened criminals' of later years? Whatever the virtues of the ecological approach, it fails to give us answers, or more than hints of answers, to these questions.

As a research document, the book leaves the critical reader dissatisfied when it comes to finding a genuine contribution to the better understanding of juvenile delinquency. Altogether, the book is too wordy, presents its evidence too unsystematically and is rather too well garnished for a scientific study. On the other hand, it is obvious that the writer is a sincere and interested youth worker, who has made a point of collecting information, albeit with some naïvety. It is perhaps not unfair to say that his aims in many ways are didactic and descriptive, rather than analytic. He wants his youngsters to "come alive to the imagination", and he feels the need for a study "with more sympathy and greater psychological depth, to place upon the bare bones of statistics the flesh and blood and spirit of recognizable humanity". This is an aim which will commend the author to many who have responsibility for the care of young people; it makes the study readable and interesting, but, where it might have 'proved' something, it can do no more than illustrate from a number of abstracted case-histories or offer a certain amount of discussion.

Perhaps, in the final analysis, the book should be read not so much as a research into juvenile delinquency, but rather as one of the relatively small number of British community studies, and as a piece of living social history. As such, it makes a valuable contribution.

A. N. Oppenheim

THE STAR CARR 'TREASURE'

Excavations at Star Carr, an Early Mesolithic Site at Seamer, near Scarborough, Yorkshire

By Prof. J. G. D. Clark. With chapters by D. Walker, Dr. H. Godwin, F. C. Fraser and J. E. King. Appendix by John W. Moore. Pp. xxiii+200+24 plates. (Cambridge: At the University Press, 1954.) 63*s.* net.

The word 'treasure' is usually confined to articles of intrinsic value; but the Mesolithic artefacts of antler and bone excavated by Prof. Grahame Clark at Star Carr, near Scarborough in Yorkshire, fully deserve this title. Their intrinsic value is nil, but the additions they make to knowledge and the speculations they arouse as to origin and relationship make them an archæological treasure to be ranked with the wonders of Sutton Hoo. During the past twenty years the Fenland Research Committee has been fostering a close co-operation between archæologists and natural historians in East Anglia. This collaboration was transferred with great success to the site discovered by Mr. John Moore at Star Carr. For three seasons the Cambridge Department of Archæology and Anthropology carried out the excavation, the Cambridge Sub-Department of Quaternary Research studied the geological, botanical and chronological implications of the site, and the Department of Zoology in the British Museum (Natural

History) preserved and studied the animal material found.

Hitherto, scholars have spoken of Baltic Forest Cultures of Mesolithic age, and have admired the wealth of barbed bone points and flint core-axes and microliths found on Danish Maglemosean sites dated to the Boreal period. The very limited quantity of similar material found in Britain, and the barbed point dredged up from the Dogger Bank, led to the assumption that there had been a diffusion of Baltic influence westward across the former dry bed of the North Sea. In this book Prof. Clark and his colleagues show us the Yorkshire countryside of Late Glacial and early Post Glacial times, and set in this environment we see a small Maglemosean lakeside settlement dated to 7500 B.C., which yielded more than twelve hundred flint implements, almost two hundred barbed points, and many other interesting artefacts. The settlement is clearly earlier than its Danish counterparts and cannot be derived from them.

The most exciting discoveries were the antler head-dresses. Skulls of male red deer, sufficiently mature to carry well-formed antlers, but still young enough not to be burdened by excessive antler weight, were selected. The skull was cut away, leaving the antlers attached to a base-plate which was thinned down and pierced by two holes. The antlers were lightened by thinning and hollowing, but the natural profile was retained. Antlers so elaborately prepared must have been worn as a head-dress, either in hunting or in ceremonial.

Summing up, Prof. Clark skilfully silhouettes the Maglemosean (*s.l.*) cultures of north-west Europe against the rapidly changing environment of the Late Glacial and early Post Glacial periods. We first see a group of Palæolithic people with Aurignacian and Magdalenian traits who utilized the burin to cut splinters out of antlers; the splinters were worked up into implements. On the Late Glacial park-tundras the reindeer was abundant, and the Hamburgian folk utilized reindeer antler only. In the birch woods of the Pre-Boreal period, red deer and elk were common, and at Star Carr the antlers of these animals were the principal raw material, though the bones of the elk and the urus were sparingly used. In the high forest of the Boreal period red deer was still common, and on the Danish sites the bones, rather than the antlers, of this animal were chiefly used.

Such important material demanded adequate publication, and Prof. Clark and the Cambridge University Press have produced a more than adequate book. There is a schedule which describes all the antler points; twenty-five are illustrated in half-tone, and line-drawings (showing three aspects) are given of one hundred and twenty. The scheduling of the one hundred and four antlers from which splinters had been cut seems scarcely justified. When so much illustration was available, it is to be regretted that the "curious spoon-like object" made from elk antler, which is only poorly shown in a preliminary publication, was not illustrated more clearly. The reduction of the illustrations is as consistent as the exigencies of size allowed, and has obviously been carefully thought out. The same cannot be said of the scales of linear measurement used. Inches, fractions of an inch, decimals of an inch, centimetres and millimetres follow one another almost on successive pages. Treatment of percentages is also uneven. When seventeen thousand flints are divided into three groups, the percentage value of the groups can certainly be carried to the first place of decimals; but when thirteen barbed points are similarly divided, little is gained by expressing the relationship of the groups by percentage values. When space has not been at a premium in the main body of the book, it seems ungracious to use a smaller face of type in the short appendix contributed by Mr. Moore. It is unfortunate that the only error also occurs here; Fig. 80 does not correspond with its caption.

The comments of the preceding paragraph do not take away from the high value to be placed on this book, which will for years to come be studied by all interested in the events of the early Post Glacial period in Europe.

G. F. Mitchell

COMMONWEALTH UNIVERSITIES YEARBOOK

Yearbook of the Universities of the Commonwealth

Thirty-second issue. Pp. lviii + 2026. (London: Association of Universities of the British Commonwealth, 1955.) 63*s*.

THIS, the thirty-second edition of the "Commonwealth Universities Yearbook", follows very closely the pattern of that published last year, but there are a number of changes, some of which are the result of recent academic developments. Thus, entries are included for the first time for two new university institutions—University College of Rhodesia and Nyasaland, Salisbury, Southern Rhodesia, and the University of Rajshahi, East Pakistan; and for two Canadian institutions which have recently been admitted to the National Conference of Canadian Universities—St. Mary's University, Halifax, Nova Scotia, and Assumption College, Windsor, Ontario. Also, for the first time, an introduction has been added to the New Zealand section, and this gives a general account of university institutions in that country, written by the Registrar of the University of New Zealand. The first appendix, on qualifications for admission to first-degree courses in universities in the United Kingdom, Canada, Australia and South Africa, has been increased to include details of faculty and departmental requirements in United Kingdom universities. The third appendix, on postgraduate awards tenable overseas by United Kingdom graduates, has been rearranged under subject headings for convenience of reference.

These are the major alterations; but, of course, there are a multitude of small changes throughout the work. Generally, it can be said that these latter are additions, for nearly all the universities of the Commonwealth are expanding, some rapidly, and year by year there is a demand for information on fresh topics. Thus the present edition is about a hundred pages longer than the previous one (an increase of about 5 per cent); but the Association is to be commended for keeping the price the same.

There are 111 university institutions in the British Commonwealth which have been granted degree-giving rights in their respective countries, 22 of which are in the United Kingdom. Together they contribute a very considerable fraction of the world's higher learning, and it is obviously a great convenience to have the principal details about them published in a single reference volume. This work amply fulfils such a need.

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH AT GENEVA

FOUNDATION-STONE CEREMONY

ANOTHER milestone was reached in the history of the European Organization for Nuclear Research, when on June 10 the foundation-stone was laid of the laboratories at the Meyrin headquarters of the Organization near Geneva, followed by the signature of an important Agreement between the Organization and the Swiss Government. The stone-laying ceremony was conducted jointly by M. Max Petitpierre, president of the Swiss Confederation, M. François Perréard, president of the State Council of the Republic and Canton of Geneva, and Sir Ben Lockspeiser, president of the Council of the Organization. The ceremonies were attended by a large number of eminent scientific workers and diplomatic and other representatives of the twelve member States, and by other guests.

The Agreement with the Swiss Government, which has generously given the site on which the laboratories are being built, will give the Organization numerous important privileges and amenities which will greatly facilitate its work. Those who have been closely associated with the years of planning came away feeling that this unique Organization has good reason to be proud of what has been achieved so far. The high level of scientific and technical competence of the research and design teams and the spirit of enthusiasm which animates all concerned provide solid grounds for confidence in the healthy growth of the new Organization.

Since last September, when the 1953 Convention setting up the Organization came into force, full advantage has been taken of the preparations of the previous years, and work has been proceeding at an ever-increasing speed, of which there is now impressive evidence at the Meyrin site. Good progress has been made with the massive foundations and the housing for the smaller of the two accelerators, the synchro-cyclotron. Its magnet and coils are being made, and it is hoped to have the machine working early in 1957. The larger accelerator, the proton-synchrotron, still presents formidable scientific and technical problems, and work is naturally less advanced. Even here, however, impressive progress has been made, and on the site itself excavation has begun on the vast circular space required to accommodate the magnet.

In his speech at the stone-laying, M. Petitpierre said that, since the time when the project was first mooted, a considerable distance had been covered and most of the eminent scientists of the day had co-operated to achieve this. It was an important occasion, for he thought it was the first time in history that a community of nations had undertaken the construction of an international scientific laboratory. There will be no secrecy whatever about the work done there, the single purpose of which is to extend the field of knowledge. The machines will place at the disposal of scientific workers very powerful instruments to open up hitherto unknown horizons. This is particularly important at the present time when the vast possibilities for the use of nuclear energy for peaceful purposes are beginning to be realized. Thanks to the initiative taken within the framework of the United Nations Organization and thanks also to the work of the European Organization for Nuclear Research, atomic energy has begun to assume a peaceful significance instead of being thought of in terms of weapons of destruction. It is the belief of the Swiss Confederation, continued M. Petitpierre, that, particularly in the field of nuclear energy where the discoveries made hitherto represent but a beginning, it is only by mutual co-operation and with the added feeling of dependence upon one another and their common destiny that nations can employ this source of energy as an instrument of progress. It is the sincere hope of the Swiss Federal Council, he concluded, that the foundation-stone ceremony will mark not only the beginning of collective scientific investigation but also that it will stand as a memorial to pacific collaboration among nations.

In expressing the pleasure of the Geneva authorities, whom he represented, M. Perréard referred to the initial diffidence of some sections of the Geneva community about the decision of the authorities to set up the Organization on Swiss territory. When the matter was put frankly before the people of Geneva, the authorities and the population were unanimously agreed to it being set up in their midst. The creation of the Organization has inevitably provided various legal problems arising from the need to harmonize the existence of national and international bodies on the same territory. The Swiss experience of various international organizations having their headquarters in Geneva has, however, enabled these problems to be settled without great difficulty, and any others which might arise will certainly be settled in the same friendly spirit. In conclusion, M. Perréard reiterated the welcome given to the Organization by Geneva with the deepest satisfaction, for thereby Geneva herself would be scientifically and intellectually the richer. He expressed the hope that the foundation stone, set in a country miraculously spared the horrors of war over so long a period, would symbolize in the field of science the spirit of mutual aid which should unite all men of goodwill to whatever country they might belong.

Sir Ben Lockspeiser, in thanking M. Petitpierre and M. Perréard, agreed that those present were participating in what was a unique occasion in the history of science. Scientific research has never been confined to any one country, and scientific thought is international in scope and character. Sir Ben stressed that the aim is both to strengthen existing national institutions for learning and research and to build up a focus of study and experiment where groups of scientific workers can together achieve what they would be unlikely, or unable, to do in isolation. It is entirely fitting, he said, that the Organization's laboratory should be established in Geneva, which has particularly the traditional atmosphere of freedom required by scientific research.

Dr. Luther Evans, director-general of the United Nations Educational, Scientific and Cultural Organization, added a personal word of congratulations on the successful progress of the European Organization for Nuclear Research, which had been established with a substantial amount of help from Unesco but which is now in a position to stand on its own feet as an independent body. Unesco, he said, is proud of the new Organization and will continue to maintain close contact with it.

JUBILEE OF THE UNIVERSITY OF SHEFFIELD

By Dr. D. H. PEACOCK

ON June 3, 1905, Mr. (later Sir) George Franklin, chairman of the Council of University College, Sheffield, brought to Sheffield the Royal Charter constituting the University. He was met at the Victoria Station by the officers of the new University and some thirty carriages filled with students and decorated in the College colours. This procession, led by the band of the Hallamshire Rifles, moved off to the old University College building, where an enthusiastic meeting was held to receive the Charter.

The College which was raised then to the status of an independent University had been formed in 1897 by the union of three institutions: Firth College, the Sheffield Technical School and the Sheffield School of Medicine.

Firth College enrolled its first students in 1880 for courses in mathematics, classics, ancient history, modern history, chemistry, physics, mechanics and the theory of music. This forerunner of the University had been founded at his own charge by Mark Firth, head of the firm of Thomas Firth and Sons and lately mayor of Sheffield, whose enthusiasm had been stimulated by the extension lectures conducted in Sheffield in the preceding few years. The eventual provision of technological courses had been envisaged from the beginning, and in 1886, largely as the result of the activity of Sir Frederick Mappin, then representative of Sheffield Corporation on the College Council, the Sheffield Technical School was opened as a branch of the College, though under separate management, and in separate buildings which have ever since remained the centre around which the University's technological departments have grown.

The Medical School had been opened by members of the profession in 1828. For a few years there were indeed two rival medical schools; but one disappeared after its buildings had been sacked by a mob. The early history of the survivor was chequered, and once at least a decision was taken to close it. Its survival was due to the devotion and self-sacrifice of a group of medical practitioners in the town, who, with the help of public subscriptions, raised the money to erect a new building, opened in 1888 opposite Firth College. Thereafter there was a close association between the two institutions, and in 1891 Firth College took over all the teaching of the preliminary sciences. When a charter for a University College was granted in 1897 the Medical School joined Firth College and the Sheffield Technical School to become the new University College's faculty of medicine.

University College, Sheffield, was constituted with the view of admission to the federal Victoria University, but in 1897 that University was already suffering from internal strain. The Sheffield College applied for admission and was refused. Soon after, the Victoria University split up, and in these circumstances Sheffield decided to apply for a university charter—a project which had never been far from the minds of the Trustees of Firth College. New buildings, designed for an extended University College, had just been completed when the charter was granted, and were opened on July 12, 1905, by King Edward VII. Around these buildings in Western Bank (about a quarter of a mile from the applied science buildings in St. George's Square) the subsequent expansion of the faculties of arts, law, pure science and medicine has taken place.

The University of 1905 owed much to the scholarship, zeal and organizing ability of the staff of University College and its predecessors. They had remained undaunted by the difficulties and delays attendant upon inadequate financial resources, and had pressed forward determinedly towards standards then not commonly accepted. In some cases the influence of what was accomplished extended well beyond Sheffield. In particular, W. M. Hicks, professor of physics (1883–1917), principal of Firth College and later of University College, and charter vice-chancellor of the University, had played an important part as the initiator, with Sir William Ramsay (then principal of University College, Bristol), of the campaign for government grants for the English university colleges, the successful outcome of which had saved some of the colleges—Firth College almost certainly—from extinction. In the arrangements made for the administration of these early—and tiny—grants may be traced the outline of the future University Grants Committee and the beginning of a movement which is transforming the civic universities into national institutions.

In the early days, of course, only a very small proportion of students were university students as we know them now. The session 1905–6 began, in fact, with 585 day students of whom only 114 were reading for degrees and diplomas. The teaching staff of the faculties of arts and science also catered for a large proportion of the 250 occasional students, some 200 evening students, and students of the Sheffield Teachers' Training College who came to the University for courses which the Local Education Authority could not then provide. One of the earliest steps taken, under the energetic leadership of J. A. Green (appointed professor of education in 1906), was the establishment of a University Training Department for Teachers, in which, by 1910–11, there were a hundred students. Degree courses in law were made available with the creation of a separate faculty in 1908. In the same year, with R. N. Rudmose Brown (professor of geography, 1931–45) as lecturer, geography was introduced into the curriculum for ordinary degrees in the faculty of pure science. Degree and diploma courses in architecture were instituted in 1913 (though it is only recently that the department has grown into one of the largest in the faculty of arts). Music, though taught since the days of Firth College (during 1890–1920 under the well-known chorus master, Sir Henry Coward), did not become a subject for degrees until 1928, when, the nucleus of a department having been built up under the influence of Sir Henry Hadow (vice-chancellor, 1919–30), F. H. Shera was appointed to a full-time chair.

On the technological side the young University was in a strong position. The equipment and facilities of the applied science buildings were among the best then available. Associateships in engineering and metallurgy, already established by Prof. W. Ripper (professor of engineering, 1889–1923; principal of the Sheffield Technical School, 1889–97; vice-chancellor of the University, 1917–19) and Prof. J. O. Arnold (professor of metallurgy, 1889–1919), were of a high standard, and were held (and have remained to this day, although superseded by degree courses) in great esteem by local industrialists. The degree and diploma courses in engineering and metallurgy

could be completed by either full-time or part-time study combined with practical experience. The early courses for the diploma in mining followed a similar pattern, as did the degree courses instituted in 1913 under F. E. Armstrong (professor of mining, 1913–21). Since then the necessary practical experience has been gained largely by vacation work. The Department of Glass Technology was instituted as the result of experience gained during the First World War. In October 1914 the University set up a Scientific Advisory Committee with W. E. S. Turner (professor of glass technology, 1920–45), then lecturer in physical chemistry, as its secretary. Turner soon realized the need for the application of scientific methods to the manufacture of glass, and a full-time course for a diploma in glass technology was established in 1916, and a degree course in 1919. Fuel technology, which had been unequally yoked with applied chemistry, was made a separate chair in 1920 (R. V. Wheeler, professor of fuel technology, 1920–39) and degree and diploma courses instituted in 1921.

The growth of the medical faculty between 1905 and 1945 owed much to the pioneer work of earlier teachers in the Medical School. Arthur Hall (professor of physiology, 1897–98, of pathology, 1899–1906, and of medicine, 1915–31) joined the Medical School as an assistant demonstrator in physiology in 1889 and strove successfully to establish full-time teaching departments in the subjects involving laboratory work. His work on behalf of the school was helped by Christopher Addison (Viscount Addison of Stallingborough, first Arthur Jackson professor of anatomy, 1897–1901). J. B. Leathes (professor of physiology, 1914–33) reorganized the courses, and did much to effect a revolution in the linking of laboratory work with clinical teaching not only in Sheffield but also throughout the country. The first full-time clinical chair was established in 1920 when Edward Mellanby was appointed professor of pharmacology, and with the chair was associated an appointment as physician at the Sheffield Royal Infirmary. When H. W. Florey was appointed to the chair of pathology in 1932, J. W. Edington became the first full-time professor of bacteriology, after having been for more than ten years responsible for both departments. A full-time professor of dental surgery (G. L. Roberts) was appointed in 1935 and a chair of biochemistry (H. A. Krebs) created in 1945. Since 1945, clinical chairs have been instituted in medicine, surgery, child health, obstetrics and gynaecology and social medicine.

The expansion in the range of studies offered at the University was accompanied by an increase in the number of students and a corresponding demand for increased teaching and residential accommodation. The natural expansion in buildings was, however, checked by the First World War and the subsequent depression. Extensions to the technological departments were completed in 1913; but further expansion had to wait until after 1930. Then, under the direction of A. W. Pickard-Cambridge (vice-chancellor, 1930–38) a new wing for the departments of pure science and extensions to the Departments of Mining and of Metallurgy were completed. In 1939 the Department of Glass Technology moved into its new building for which funds had been raised by the glass industry. The Second World War interrupted the building programme. During the War, under the leadership of Sir Irvine Masson (vice-chancellor, 1939–52), the University had made notable contributions to the war effort both in research and in production. As soon as the War ended, plans were drawn up to serve the increased number of students which the University was called upon to train. Extensions to the Department of Mining were opened in 1953, and a large new building to provide expanded facilities in teaching and research in the Departments of Civil, Mechanical and Electrical Engineering was opened by the Minister of Defence in April this year. Post-graduate schools in physical metallurgy were opened in 1950, in applied mechanics in 1951 and in mining in 1952. This expansion in applied science naturally requires expanded provision for teaching and research in the fundamental pure sciences. A new building for chemistry was opened in 1954, and the accommodation vacated has been altered for the use of departments in the faculties of pure science and of medicine. The necessary sites in the neighbourhood of Western Bank have been acquired for a complete University Quarter, and plans for new buildings for the library, arts, law, physics, the Medical School and administration have been drawn up.

All this expansion has provided, and is providing, domestic problems of considerable magnitude. The public spirit of Sheffield ladies was soon stirred to arrange halls of residence for women students. Soon after 1930 three of these small halls were united in one larger hall. At about the same time the first hall of residence for men was built and a Students Union provided by the generosity of J. G. Graves. Additional halls of residence for men were opened in 1947 and in 1952. A full-time warden of lodgings was appointed in 1947, and the student health service set up in 1948 now has three full-time medical officers. Extensions to the halls of residence are planned, as are new buildings for the Students Union, refectories and a staff house. A new playing field near the University has been opened, and the site for another acquired. The material resources planned are impressive; their use will depend on character and ideals.

Universities exist to extend knowledge, to conserve knowledge and to hand on knowledge. Sheffield can claim that it has performed all these functions in the past and can, with some degree of confidence, hope to continue to perform them in the future.

COLOUR SPECIFICATION

POSSIBLE REVISION OF THE C.I.E. SYSTEM

ALTHOUGH the principles of colour-matching with mixtures of three coloured lights were worked out in the latter half of the nineteenth century —notably by Helmholtz, Maxwell, König and Abney —it was not until 1931 that an agreed system of colour specification based on these principles was adopted. The essential preliminary was an adequate knowledge of the colour-matching properties of the average colour-normal eye. During 1927–30 excellent investigations of colour-matching by Guild and Wright respectively, using different groups of subjects, gave closely concordant results for a vital part of the information required, namely, the quantities, two positive and one negative, of the three component lights in a mixture to match an unspecified amount of each of the spectral colours. (The negative sign means that in the match the component light has to be mixed with the spectral stimulus.) The Commission Internationale de l'Éclairage had

earlier adopted a standard visibility function V_λ defining the reciprocal intensities in energy units of spectral stimuli having the same brightness or luminosity for the average eye. A combination of the mean Guild–Wright data with the standard visibility function V_λ enabled the Commission to adopt, in 1931, a complete quantitative basis for colour specification, that is to say, a tabulation of the colour-matching functions or quantities of three component lights in a mixture to match unit energy intensity of each of the spectral colours. The component lights for which the Commission agreed the basic data were three spectral stimuli (700·0, 546·1 and 435·8 mμ), but for colour specification it was decided that the data should be transformed to a different set of mixture components, the so-called C.I.E. reference stimuli. The C.I.E. reference stimuli coincide with no actual physical stimuli—their relation to such stimuli is something akin to that between a virtual and a real image in geometrical optics—but this unreality is more than compensated for by the practical advantage of leading to positive colour co-ordinates for all real colours. The C.I.E. system is to-day the one fundamental system of colour specification in all branches of colour technology.

In reviewing the recent discussion by the Physical Society's Colour Group on April 27, it is first of all necessary to emphasize that no grave errors or shortcomings of the existing system have been brought to light, and those who have accepted and used it need not fear that their confidence has been misplaced. But there have been questionings which touch the underlying principles, the experimental data and the choice of reference stimuli. Work by Blottiau (1947) and Trezona (1953–54) suggests that the additive law of colour-matching, as applied to the measurements of a particular subject, is only approximately true. Again, while an indirect determination of the colour-matching functions by way of a V_λ function may give correct results, it would appear preferable to use a direct method not involving heterochromatic photometry. As it turns out, doubts about the V_λ data incorporated in the C.I.E. system initiated the move towards a revision. There is evidence that at short wave-lengths the values are too low. Considerable attention has been given to the additivity of brightness in heterochromatic photometry. This issue—quite distinct from the additive law in full colour-matching already referred to—would have no bearing on colour specification by the trichromatic method but for the fact that V_λ data were used in setting up the present C.I.E. system.

It may be said that any significant defect in the basic data of the C.I.E. system would have shown itself in use before now. Only one serious claim has been made that in a technological application the C.I.E. system gives demonstrably incorrect predictions about colour matches. This fact must not be rated too high. Opportunities for clear-cut tests are not common and, because of the considerable individual differences in colour-matching, any discrepancy between the results of an actual observer and the computed result for the C.I.E. standard observer is likely to be laid at the door of the former. In one group of applications it would appear that the C.I.E. data cannot be giving quite the correct answers. This is when colour-matching of patches subtending considerably more than 2° at the eye are concerned. The standard data refer specifically to a 2° field, and it is known that field-size is a significant factor. Obviously, if only one set of colour-matching functions is to be standardized, it cannot be completely satisfactory for all practical field-sizes. But the best choice of field-size or the best compromise is not easy to determine.

The changes proposed in the C.I.E. reference stimuli have been mainly directed towards incorporating in the C.I.E. system additional information about colour perception. Every colour is characterized by three numbers—the unit co-ordinates x, y, z, of sum unity—and it is customary to represent the colour by a point in a rectangular (x, y) plot. Experiments on colour discrimination show that in the C.I.E. (x, y) diagram the distance apart of two points corresponding to stimuli equally bright but just perceptibly different in colour varies very widely in different colour regions. No transformation to new reference stimuli would give a perfect 'uniform chromaticity' diagram, but a considerable improvement over the C.I.E. diagram is possible. Other properties of colour perception emerge when we are concerned with the colour relations of pigmented surfaces viewed, under a suitable illumination, on a 'white' background. The representation of these properties is simpler with some choices of reference stimuli than with others. At the Physical Society's Colour Group meeting, Dr. R. W. G. Hunt urged the merits of a uniform chromaticity diagram due to MacAdam, while Mr. R. G. Horner favoured a more radical change in the method of plotting colour co-ordinates, adapted to represent surface colours.

The new experimental material which the Commission will have considered in discussing revision of its system in June includes studies of the V_λ function in the blue end of the spectrum made respectively at the National Bureau of Standards, Washington, D.C., by Ishak and Teele, and at the National Physical Laboratory, Teddington, by Burch and Stiles, and a direct determination (that is, not involving the V_λ function) of the colour-matching functions for 2° and 10° matching fields with spectral stimuli as the mixture lights. For the latter work, also being carried out at Teddington, the results for an initial group of ten subjects are now available. The new results for the 2° field show certain interesting, if minor, deviations from the present C.I.E. values, deviations which are not attributable to the use of an inappropriate V_λ function in the derivation of the C.I.E. system nor to differences of average eye pigmentation of the various groups of subjects concerned. These are additional to some deviations in the blue end of the spectrum which could spring from the factors mentioned. A difference in the conditions of the new work at the National Physical Laboratory as compared with that of Guild and Wright is the use of a 'blue' mixture light of shorter effective wave-length—about 445 mμ instead of 460 mμ. This should be immaterial, if the additive law for complete colour-matching is strictly true. A direct test of the effect on the unit co-ordinates of changing the 'blue' mixture stimulus from 460 to 445 mμ had already been made for his own eye by Prof. W. D. Wright using his own spectral primary colorimeter, and the results, described at the Colour Group meeting, confirm the implication that the colour-matching functions may not be completely independent of the mixture colours used in their determination*. The results of similar comparisons being made at the National Physical Laboratory will be available shortly. The whole question of indivi-

dual obedience to the additive law of colour-matching is of the first importance in visual theory. The bearing on colour specification in the C.I.E. system is of a different kind, and the practical outcome is perhaps less disturbing than might at first appear. If, as seems probable, additivity ambiguities are of no higher order of magnitude than individual differences in colour-matching properties and differences arising from the wide range of practical conditions of colour observation, the extra load on a 'standard observer', who must represent a compromise over all these variations, may not be great. But the problem of the best compromise is changed, and until we have a clearer picture of the additivity difficulties we would be ill-advised to alter the present system. This is so, even though on some points—such as the values of the colour-matching functions in the extreme blue, which are shown by all the new work to be too low in the C.I.E. system—some improvement would be possible now. For colour technology, a change in the C.I.E. system means an upheaval—computations of new tables, adjustments of all kinds of colour specifications, modification of physical colorimeters, etc.—and it would be unthinkable to make an interim change now with the possibility of a further change a year or two later.

* *Note added in proof.* Prof. Wright has made additional measurements which avoid an uncertain interpolation previously involved. He now finds virtually no difference between the unit co-ordinates of the spectral colours obtained by the use of 'blue' primaries 445 and 460 mμ, respectively. The National Physical Laboratory comparisons, since available, also show only slight differences in the unit co-ordinates, although there appears to be a small change in the 'blue' colour-matching function.

W. S. Stiles

OBITUARIES

Dr. R. N. Salaman, F.R.S.

In Redcliffe Nathan Salaman, whose death occurred on June 12, aged eighty, the world has lost one of the grand old men of science. He was one of the very few remaining representatives of a world of learning that had not known the spectre of modern specialization, a world where the boundaries between one science and another were scarcely recognized and even those between science and the humanities were comfortably bridged. Dr. Salaman's whole life and work illustrated this.

Born in September 1874, he attended St. Paul's School and became a scholar of Trinity Hall, Cambridge, where, though he was for some unaccountable reason never a Fellow, he was a familiar figure in the combination room for many long years. He began his scientific career in medicine, at the London Hospital, and in 1901 was made director of the Pathology Institute there. But this was the time when the spectacular rediscovery of the Mendelian laws of heredity had given birth to the new science of genetics; Salaman was one of the first in Great Britain to become interested in Mendelism and soon joined William Bateson's original group of British geneticists.

It was characteristic of him that his interest in the Mendelian laws embraced both their direct implication in relation to studies of the origin and relationships of racial groups in man and their indirect use in the improvement of one of man's chief food crops, the potato. In both these fields he published some of the first scientific studies; he was made director of the Potato Virus Research Station at Cambridge on its foundation, and in his work there was the first to make use of a wild relative of the domestic potato, since recognized as the Mexican species *Solanum demissum* or a derivative, in order to introduce resistance to potato blight, *Phytophthora infestans*, into cultivated potatoes. To this day *S. demissum* remains one of the main sources of resistant genes.

Salaman it was who in 1930 recognized the dawn of a new epoch in potato breeding with the Russian discovery of a whole polyploid series of relatives of the potato—some wild, some cultivated—growing in the Andes in South America; he took an active interest in the expedition sent by the British Commonwealth to collect these potatoes and in the foundation of the Commonwealth Potato Collection and the Potato Research Station at Cambridge which resulted from the expedition. Characteristically again, Salaman's imagination was fired by these potatoes just as much for their anthropological as for their genetical and agricultural significance; indeed, his book on the subject, entitled the "History and Social Influence of the Potato", is cited as much by historians and anthropologists as it is by geneticists or plant breeders; for these latter Salaman's researches have thrown light on the origin of the cultivated potato, its early introduction into Europe and its relationship to other, more primitive, potato species. For all readers it serves as an illustration of how an eminent scientist may yet be a master of English literary style—a fact also appreciated by anyone who has attended one of the many lectures that Salaman was so often called upon to deliver.

In 1935 Salaman was elected to fellowship of the Royal Society. In spite of his multifarious activities in the fields of medical pathology, plant genetics, phytopathology and anthropology, he was one of those busy people who always find time for something else. Living as a country gentleman at Barley in Hertfordshire, he was surrounded by a large family, took an active part in local good works, and in the critical years of the Nazi and other persecutions made an energetic contribution to the activities of the Council for the Protection of Science and Learning. In London he was a familiar figure in the rooms of the Athenæum, and there are few men of the present day who can be said to have led a more varied and constructive life, embracing so wide a field of diverse interests and activities.

P. S. Hudson

Prof. D. B. Blacklock, C.M.G.

The death occurred on June 10 of Donald Breadalbane Blacklock, emeritus professor of tropical hygiene in the University of Liverpool. He was born on January 7, 1879, at Oban, Argyllshire, and was educated at Fettes College and at the University of Edinburgh, where, after a distinguished career both in studies and in sport (he played cricket for the University and rugby for Edinburgh Wanderers), he graduated M.B., Ch.B. in 1902, proceeding to the degree of M.D. in 1909. In 1911 he was appointed to the Runcorn research laboratory of the Liverpool School of Tropical Medicine, where he worked, first as research assistant and later as director, until 1914, when he was appointed lecturer in parasitology to the Liverpool School.

During this early period of his career, Blacklock published a series of twenty-one papers on trypanosomiasis, most of them in his own name, but some in collaboration with Warrington Yorke. They were chiefly concerned with the morphology of trypanosomes; but in one of them the important discovery was recorded that *T. cruzi* could undergo development to the infective stage in the bed-bug.

In 1914, Blacklock and Yorke joined the School's thirty-second expedition, which was dispatched to West Africa, and, while in Sierra Leone, studied the breeding places of *Glossina palpalis* and the various species of trypanosomes transmitted by the fly to man and his domestic stock. By the time that the expedition had returned to England, war with Germany had broken out. Blacklock joined the R.A.M.C. and served with it, both at home and abroad, from 1915 until 1919, actively continuing with research during his period of service, and collaborating with Stephens, Yorke and other colleagues in a symposium of more than thirty papers on the treatment of malaria.

In 1921, when the Sir Alfred Lewis Jones Research Laboratory was opened in Freetown, Sierra Leone, by the Liverpool School, Blacklock was appointed its first director and was given the title of professor of tropical diseases of Africa by the University of Liverpool. The eight years which followed represent the most active and productive part of Blacklock's long scientific career. During that time he published more than forty papers on a wide range of problems concerned with various aspects of schistosomiasis, beriberi, malaria, trypanosomiasis and goitre, the most outstanding of which demonstrated for the first time that *Onchocerca volvulus* was transmitted to man by *Simulium damnosum*—a discovery of notable importance in the history of tropical medicine. In 1929 Blacklock returned to Liverpool to succeed Yorke in the Walter Myers chair of parasitology, which he held until 1934, when he was appointed the first holder of the newly established chair of tropical hygiene.

During the Second World War, Blacklock, then nearly sixty-five, was sent to Freetown on a Government mission with the rank of surgeon-captain to investigate the malaria situation at the port and to submit recommendations for its control. His report led to a concentrated attack on the vector anophelines and resulted in the elimination of malaria from the port and the protection of convoys using it. For this and other notable services he was awarded the C.M.G. in 1942.

He retired from the chair of tropical hygiene in 1945, and in 1949 the Liverpool School of Tropical Medicine presented him with the Mary Kingsley Medal, as a fitting tribute to his work in West Africa and elsewhere.

Blacklock was a man of striking presence, handsome in appearance, gentle and reserved in manner, his innate kindliness lit from time to time with flashes of brilliant wit. His clear incisive mind made him an excellent lecturer, and his text-book on human parasitology, written in collaboration with Dr. Thomas Southwell and now in its fifth edition, is proof of his powers as a teacher.

He is survived by his wife, Dr. Mary Georgina Blacklock, C.B.E., who accompanied him on his many travels and who collaborated in some of his scientific work.

R. M. Gordon

NEWS and VIEWS

Applied Mathematics at Sheffield: Prof. D. N. de G. Allen

Mr. D. N. de G. Allen, reader in applied mathematics at the Imperial College of Science and Technology, London, has been appointed to the newly created chair of applied mathematics in the University of Sheffield. Mr. Allen is a graduate of the University of Oxford, and received his early training in research under the direction of Sir Richard Southwell at the University Engineering Laboratory, where he became interested in the newly developed relaxation methods as applied to engineering problems. Later, when Sir Richard became rector of Imperial College, Allen accompanied him there and played a large part in the establishment of a research team concerned with relaxation methods. He was appointed lecturer in the Mathematics Department of Imperial College in 1945, and later became reader, then taking over much of the responsibility for the teaching of mathematics to students of engineering. Under his guidance there has grown up at the Imperial College a thriving and productive group of research workers able to apply successfully relaxation techniques to a variety of mathematical problems of engineering interest. In 1949 Allen visited the Massachusetts Institute of Technology to deliver courses of lectures on subjects related to his own field of research, and later, in 1954, he paid a short visit to India for the same purpose. In addition to his interests in teaching and research, Allen has played a full part in the general and social activities at the Imperial College, and though he will be greatly missed by all his colleagues there, he takes with him their very good wishes to his new responsibilities at the University of Sheffield.

University College of Rhodesia and Nyasaland: Prof. E. B. Edney

The appointment of Dr. E. B. Edney, reader in Entomology in the Department of Zoology and Comparative Physiology, University of Birmingham, to the chair of zoology in the newly created University College of Rhodesia and Nyasaland, Salisbury, Southern Rhodesia, cannot fail to please those concerned about the future of academic biology in the British Commonwealth. Dr. Edney is an entomologist with a distinguished research record in the field of arthropod physiology and ecology, where his work on water relations and microclimatology has produced results of considerable theoretical and methodological importance. As a systematist, he has specialized in the taxonomy of two widely different arthropod groups, the Chrysididae and Isopods, and has published monographs on both. His past association with academic work in Africa at Rhodes University College, at the National Museum in Bulawayo and at Makerere College, Uganda, has recently been rounded off by a successful research expedition to the Sahara. As a senior member of the teaching staff of the Zoology Department in Birmingham, Dr.

Edney has excelled by his wide knowledge and interest in all fields of the subject, including the complex problems of primate evolution, and by his qualities as a teacher of undergraduate and post-graduate students. He is also an experienced and capable administrator, and his dispassionate matter-of-factness has always been greatly appreciated by his colleagues in committee. When the foundation of a new University College on the African Continent had become a welcome reality, the question of who would be made responsible for the development of teaching and research in the biological sciences was a matter of great interest in view of the natural opportunities offered at Salisbury. Those responsible for the present appointment are to be congratulated on having made a most appropriate choice.

Prof. A. S. Boughey

In appointing Prof. A. S. Boughey to its chair of botany, the University College of Rhodesia and Nyasaland has selected a botanist with a wide experience of tropical Africa, and a background which should prove most valuable in this post. After taking a research degree at Edinburgh, Prof. Boughey proceeded to the Sudan, where he spent the war years as plant pathologist in the Department of Agriculture. He returned to Britain to teach botany in the University College of the South-West; but when the University College of the Gold Coast was established in 1948, he was one of the first appointments to the staff, as professor of botany. During the following years, he succeeded in building up a strong department which, though in temporary premises, was well equipped and well staffed, and soon became an efficient instrument of teaching and research. While in the Gold Coast, Prof. Boughey gave particular attention to developing a herbarium as a research tool, and to establishing a large botanical garden. In recent years, his research interests have mainly been in descriptive ecology; he has studied the vegetation types along the Guinea coast, and has given special attention to altitudinal zonation in the mountain massifs of West Africa, particularly the Cameroons Mountain. He will take to Salisbury experience from two other very different parts of the African continent, and a record of success in building up a new botany department from the foundations under similar conditions. This should augur well for the future of botany in Rhodesia.

Peaceful Uses of Atomic Energy

Further details have recently been announced on the International Conference on Peaceful Uses of Atomic Energy, which will be held in Geneva during August 8–20 (see *Nature*, April 9, p. 615) in association with two exhibitions (see *Nature*, May 28, p. 929). The official delegation from Great Britain will consist of Sir John Cockcroft, director of the Atomic Energy Research Establishment, Harwell; Sir Christopher Hinton, managing director of the United Kingdom Atomic Energy Authority Industrial Group; Dr. J. F. Loutit, of the Medical Research Council and Agricultural Research Council; Sir George Thomson, of the Royal Society, representing British universities; and Dr. Willis Jackson, of Metropolitan-Vickers Electrical Co., Ltd., representing British industry. Sir Edwin Plowden, chairman of the United Kingdom Atomic Energy Authority, will also attend, and advisers to the delegation will include representatives of the Atomic Energy Authority Research and Industrial Groups, the Chemical Research Laboratory, the Medical and Agricultural Research Councils, the Department of Scientific and Industrial Research, the Ministry of Defence, the Ministry of Fuel and Power, the Institution of Civil Engineers, British universities and a number of industrial concerns. The total number of delegates, advisers and staff for the conference and exhibitions, excluding the industrial representatives attending the exhibitions, will be more than a hundred and sixty. More than a hundred papers were submitted to the United Kingdom Papers Committee, and sixty-seven will be read, the remainder being included in the report of the proceedings which will be published. Including those from Britain, more than a thousand papers were submitted altogether, and, of those selected for reading, more than seventy will be from the U.S.S.R. and about a hundred and seventy from the United States. Other countries presenting papers are: Australia, Belgium, Brazil, Canada, Czechoslovakia, France, India, Israel, Japan, Norway, Poland, Portugal, Sweden, Switzerland, The Argentine, The Netherlands and Yugoslavia.

Pan-Malayan Scientific Advisory Council

As a result of a suggestion made by the Commission on University Education in Malaya that a scientific advisory council should be set up, representing the Governments of the Federation of Malaya and of Singapore and the University of Malaya and including experts from the planting and mining industries and the fields of agriculture and medicine, the Pan-Malayan Scientific Advisory Council has been formed, with the Chancellor of the University of Malaya as president. Its functions are to promote the spread of scientific information; to advise on scientific problems relating to Malaya; and to advise on, and assist in, the co-ordination and finance of scientific research, with power to receive and administer endowments, donations and grants. Participation in the work of the Council and its Committees by the Governments of Sarawak, North Borneo and Brunei will be welcomed, if they so desire. The main work of the Scientific Advisory Council will be undertaken by technical committees, six of which have been set up, each under its own chairman, as follows: *Animal and Vegetable Life and Resources*, Mr. D. W. Le Mare, P.O. Box 459, Penang; *Medical and Veterinary*, Dr. J. W. Field, Institute for Medical Research, Kuala Lumpur; *Economic Affairs*, Sir Sydney Caine, University of Malaya, Singapore; *Mineral Resources*, Prof. E. H. G. Dobby, University of Malaya, Singapore; *Physical Sciences*, Prof. R. A. Robinson, University of Malaya, Singapore; *Social Science and Anthropology*, Prof. T. H. Silcock, University of Malaya, Singapore. The chairmen of the six technical committees, together with three representatives from the Government of the Federation of Malaya, two from the Government of Singapore and two from the University of Malaya, form a Central Committee, under the chairmanship of the Assistant Commissioner-General for Colonial Affairs. The technical secretary of the Pan-Malayan Scientific Advisory Council is Dr. Kiang Ai Kim, of the University of Malaya, Singapore.

Veterinary Reviews and Annotations

Veterinarians and all those who are in any way interested in the welfare of domesticated animals will welcome the appearance of the new half-yearly journal, *Veterinary Reviews and Annotations*, published by the Commonwealth Agricultural Bureaux,

Farnham Royal, Slough, Bucks (1, Part 1; April 1955; pp. 54; 25s. a year). The journal is edited by W. A. Pool, who is also the editor of the *Veterinary Bulletin* and the "Index Veterinarius". The first issue contains three articles, all of which are valuable summaries of knowledge of the subjects with which they deal. Prof. R. Lovell, professor of bacteriology in the Royal Veterinary College, London, contributes a 27-page review on intestinal diseases of young calves, with special reference to *Bacterium coli*. A section of the review deals with acute gastro-enteritis of babies. The bibliography covers more than four pages, and reflects the scope and detail with which the subject is treated. The second article, by Dr. C. Horton-Smith, of the Animal Health Trust's Poultry Research Station, Houghton Grange, Huntingdon, is a valuable review, also well documented, of coccidial and other forms of parasitism in their relation to poultry husbandry. He discusses the risks and advantages of the free-range, semi-intensive, intensive (with built-up litter), folding and wire-floored cage systems of poultry management in relation to the infection of chickens with the pathogenic species of Coccidia and with tapeworms and roundworms. Everyone who is concerned with poultry management should read this up-to-date and detailed review. The third article, by Dr. Phyllis Croft, of the Group Laboratory, Mile End Hospital, London, discusses euthanasia. She deals first with the appreciation of pain by animals and then with methods used to produce euthanasia. A feature of this article is the humane spirit evident in the author's discussion of the development of the methods now being used and of the reasons why older methods have been condemned by the British Veterinary Association and others. If succeeding issues of this new journal reach the standard attained by this first issue, the journal will be an indispensable addition to the reorganization of veterinary literature that has been going on during recent years.

The Mauritius Institute

The project for an institute in Mauritius began in 1880 with the object of establishing an institute, museum and library for the "purpose of promoting the general study and cultivation of the various branches and departments of Art, Science, Literature and Philosophy and for the instruction and recreation of the people". The present building was completed in 1884 and the Institute is administered by a Board of Directors. Plans have been prepared to make the Institute more or less autonomous, and the necessary legislation is being drafted. A number of local scientific and cultural societies have become incorporated with the Institute, which at the present time comprises a library, an art gallery and a museum. The Natural History Museum is in Port Louis and the historical material at Mahebourg. At the latter the exhibits include furniture, objects connected with the Grand Port battle, and early maps, lithographs and water-colours recording the life, scenery and customs of the people at different periods. The Natural History Museum is now regional in character, and emphasis is centred on Mascarene topics illustrating biological, ecological and economic relationships. A concentrated effort is now being made to modernize the exhibition part of the Museum according to present-day standards. Research has always played an important part in the activities of the Institute, and the annual list of original papers is impressive.

First Ascent of Mont Blanc

When Mount Everest was finally conquered by Edmund Hillary and Tenzing Norkey on May 29, 1953, the event aroused enormous interest, and all the resources of ancient and modern methods of communication by runner, telegraph and wireless were available to spread the news rapidly all over the world. It arrived in Great Britain three days later, during the night of June 1–2, and one of its first recipients was the Queen. In the *Notes and Records of the Royal Society of London*, Sir Gavin de Beer and Max H. Hey show that conditions were very different when Mont Blanc was first ascended by Dr. Michel-Gabriel Paccard and Jacques Balmat on August 8, 1786 (11, No. 2; March 1955). The news was carried by messenger from Chamonix to Geneva for the information of H. B. de Saussure, who received it on the morning of August 10. Thereafter the spread of the news was sporadic, uncertain and slow, depending on the private correspondence of de Saussure and his friends and of tourists who chanced to be at Chamonix at the time. It was first published in the *Leipziger Zeitung* of August 23, 1786; but the first publication in Great Britain appears to have been in the *Scots Magazine* for November of that year. Yet it also was a great and important event, and a small number of persons in Great Britain must have learned the news privately.

Institution of Telecommunication Engineers, India

The Institution of Telecommunication Engineers was inaugurated in India in November 1953, and at the first annual general meeting held recently in New Delhi, considerable progress in membership and activities was reported. The Institution comprises all the specialized branches of telecommunications in India, and its membership of more than a thousand is drawn from various government-operated communications agencies, the three defence services, research institutes and industry. Like most professional bodies, the Institution prescribes minimum educational qualifications and experience for entry into its several categories; but direct admission into the lower categories is also possible by passing the examinations which are to be conducted by it. The first issue of a quarterly *Journal* is about to be published. Talks and discussion meetings are arranged periodically in New Delhi, the headquarters of the Institution, and similar activities are being planned in Bombay, Calcutta, Madras, Poona, Bangalore and Jabalpur. Further particulars can be obtained from the honorary secretary of the Institution at Post Box No. 481, New Delhi.

Colorimetry and Theories of Colour Vision

In an address given to the Physical Society Colour Group on May 18, Dr. D. B. Judd, of the National Bureau of Standards, Washington, D.C., said that colorimetry can contribute to the understanding of the mechanisms underlying the seeing of colours in three ways: by determining metamers, that is, several groups of different spectral stimuli which when mixed produce identical sensations; by the characterization of the attributes of chromatic sensations, particularly hue sensation; and by determining the spacing of subjective colours. As regards the first, the law of additivity, on which the interpretation of all colour matches is based, is not at present thought to be rigidly valid, although it is certainly a good approximation to the truth. Dr.

Judd emphasized that any theory of colour vision must be so framed that it can be expressed in terms of a triple matrix which is necessary to account for metamerism. This is true of the Müller zone theory, which also predicts correctly the locus of constant saturation in a colour chart; its third stage, just as Hering's theory, can account for the Brücke–Bézold (constant hue) phenomenon. In describing the Munsell colour system, Dr. Judd said that American colorimetrists have recently, and reluctantly, reached the conclusion that it is impossible to devise a single system for constant hue, saturation and brightness and simultaneously to have equal geometrical spacing. Their present object is to develop a 'homogeneous isotropic colour space'. Showing data in which photoelectric measurements and numerous subjective judgments of the appearance of ceramic samples were correlated, he said that in general the correlation is better for red than it is for buff, and for this colour it is better than it is for brown (red samples reveal a breakdown of the Brücke–Bézold phenomenon). Dr. Judd concluded by pointing out that colorimetrists have accumulated a vast body of data which awaits digestion and treatment on a theoretical basis. Not one of the least tasks of theories of colour vision will be to account for the magnitudes of the sensory differences as encountered in the above correlative experiments.

Flora of Egypt: a Further Contribution

With the appearance of Vol. 3 of the "Flora of Egypt" (published as a Bulletin of the Faculty of Science, No. 30, pp. 1–644; Cairo University, 1954), this ambitious and scholarly floristic study has been taken a stage further. In this volume the authors, Vivi Täckholm and Mohammed Drar, deal with Angiospermae, part Monocotyledones, Liliaceae–Musaceae. This detailed and thorough piece of work incorporates a revision of all the available botanical materials, together with an extensive reference list. The citation of the localities in which the species and varieties have been recorded should be of value in ecological and other researches, while the references to the medicinal and other practical uses of species, and to linguistic, historical and artistic aspects not only carry their own interest—and in some instances this is a very considerable interest indeed—but also make a very real and substantial contribution to general scholarship. As an indication of the authors' treatment, the account of the genus *Allium* extends over some seventy-eight pages and includes a general treatment of the genus; a practical diagnostic key; an account of the species, their localities and varieties; notes on the species cultivated in Egypt; records of *Allium* in Ancient Egypt (with linguistic notes, *Allium* species as food, as used in mummification, etc.); the genus in later historical periods; its use as drugs; and an extensive bibliography.

Bread Rolls made with Fish Flour

In co-operation with the Chilean Government, the Food and Agriculture Organization of the United Nations has recently completed successful large-scale trials with a protein-rich fish flour which is free from a fishy flavour. One hundred and forty Chilean children between five and fourteen years old were given daily a 90-gm. bread roll containing 10 per cent of fish flour with their school lunch. The bread was slightly darker than ordinary bread, but similar in smell, taste, form and consistency, and was eaten by the children without complaint and with no digestive ill-effects. These tests by the Food and Agriculture Organization are of great importance to technically under-developed countries where diets are low in high-grade animal proteins. Foods to meet these deficiencies must be cheap and be able also to stand transport and storage, often under most unfavourable conditions, without deterioration. Edible fish meal, or fish flour, meets these conditions. It is inexpensive, the protein content is high and processing costs are low. Until recently, however, the fishy flavour has made it unpopular, and efforts have been made to develop a flavourless fish flour. The flour used in the Chile tests was produced by a South African firm which has been working for some time on a secret process. The United Nations Children's Fund has now set aside funds to be spent on similar trials of fish flours in other areas with the assistance of the Food and Agriculture Organization.

Zoological Nomenclature

The International Commission on Zoological Nomenclature gives notice that, as from November 31, 1955, it will start to vote on the following cases involving the possible use of the plenary powers for the purposes specified against each entry. Full particulars of these cases were published on May 31 in the *Bulletin of Zoological Nomenclature* (**11**, Parts 5 and 6; 1955). (1) *Sphenodon* Gray, 1831 (Cl. Reptilia), validation of emendation from *Sphaenodon*; Sphenodontidae Cope, 1870, validation of; (2) *Hemiprocne* (Cl. Aves), validation of, as from Nitzsch, 1829; (3) *Fistulipora* McCoy, 1849 (Cl. Bryozoa), validation of; (4) *Aucella* Keyserling, 1846 (Cl. Lammellibranchiata), validation of; (5) *Muntiacus* (Cl. Mammalia), validation of, as from Rafinesque, 1815; (6) *Scorpio* Linnaeus, 1758 (Cl. Arachnida), designation of *Scorpio maurus* Linnaeus, 1758, as type species of, and suppression of *europaeus* Linnaeus, 1758; (7) *Oxypoda* Mannerheim, 1831 (Cl. Insecta, Order Coleoptera), designation of *Oxypoda spectabilis* Maerkel, 1844, as type species of; (8) *gambianus* Ogilby, 1835 (Cl. Mammalia), validation of, and designation as type species of *Heliosciurus* Trouessart, 1880; (9) *silvestris* Schreber, [1777], validation of, as name for European wild cat; (10) *Phacochoerus* Cuvier, 1826 (Cl. Mammalia), validation of; (11) *Odobenus* Brisson, 1760 (Cl. Mammalia), validation of. Proposals are also made for the adoption of 'declarations' defining (*a*) the expression 'monotypical genus', and (*b*) the combination to be attributed to the specific name for a species described as belonging to one genus, but for which at the same time a second nominal genus is established conditionally. Attention is also directed by the Commission to the proposed rejection of names given to the 'Piltdown Man' as being names given to a fictitious form. Comments should be sent as soon as possible to Francis Hemming, secretary to the Commission, 28 Park Village East, Regent's Park, London, N.W.1.

University of Sheffield

The following appointments have been made in the University of Sheffield: Dr. G. Porter, to the newly established chair of physical chemistry; Dr. V. R. Pickles, senior lecturer in physiology; Dr. G. M. Leak, lecturer in physics; Dr. W. F. Ford, lecturer in refractory materials; Dr. L. Ainsworth, lecturer in glass technology; and Miss H. G. Medlicott, map-curator and librarian in the Department of Geography.

Medical Fellowships of the National Research Council, Canada

The National Research Council of Canada has recently awarded six senior medical research fellowships and twenty-one graduate medical research fellowships, totalling 81,700 dollars in value plus travelling allowances when required. The recipients and the places where they will work are as follows. *Senior Medical Research Fellows:* Dr. W. G. B. Casselman, Banting and Best Department of Medical Research, University of Toronto; Dr. C. N. Crowson, Department of Pathology, Queen's University, Kingston, Ontario; Dr. J. M. Finlay and Dr. R. W. Gunton, Toronto General Hospital and the Department of Medicine, University of Toronto; Dr. P. C. Fitz-James, Department of Bacteriology and Immunology, University of Western Ontario; Dr. J. W. Pearce, University of Western Ontario. *Graduate Medical Research Fellows:* Dr. C. W. Baugh, Department of Physiology, Queen's University, Kingston, Ontario; Dr. S. A. Carter, Dr. W. B. Ewart and Dr. G. F. Winkler, Department of Physiology and Medical Research, University of Manitoba; Dr. R. W. Cornett, Department of Medicine, Harvard Medical School; Dr. J. W. Dawson, Department of Pathology, Banting Institute, University of Toronto; Dr. C. J. P. Giroud, Department of Investigative Medicine, McGill University; Dr. H. Kalant, Department of Biochemistry, University of Cambridge; Dr. Dorothy C. H. Ley, Toronto Western Hospital; Dr. J. Loiselle and Dr. A. E. Malkin, Department of Biochemistry, McGill University; Dr. A. M. Lansing, Department of Physiology, University of Western Ontario; Dr. G. G. Mathieson, Department of Neurophysiology, Montreal Neurological Institute; Dr. J. McGraw, Institute of Experimental Physiology, Laval University; Dr. I. R. McLean and Dr. R. Volpe, Department of Medicine, Toronto Western Hospital; Dr. J. W. Meakin and Dr. J. C. Nixon, Department of Biochemistry, University of Toronto; Dr. J. H. Mowbray, Department of Pathology, University of Toronto; Dr. J. G. J. Pepin and Dr. B. Therien, Department of Clinical Research, Hotel Dieu Hospital, Montreal.

Nuclear Engineering Courses at New York University

The College of Engineering of New York University is setting up a number of courses in nuclear engineering for students who already have a bachelor's degree in science or engineering and who wish to proceed to the new degree of master of nuclear engineering. Subject to the approval of the United States Atomic Energy Commission, a sub-critical reactor will be built this autumn at the University at a cost of a few thousand dollars, with uranium lent by the Commission. It will consist of a five-foot tank of water in which two tons of uranium rods are placed; the neutron source, consisting of polonium and beryllium, will be housed beneath floor level and will be hoisted up among the uranium rods by remote control. The power will be 1/300 W., and the neutron intensity of the order of a hundred million neutrons per second. This is enough for such experiments as foil irradiations, Geiger-counter studies, and Szilard–Chambers observations. With this apparatus students can be trained in a realistic and practical manner in the physics of the chain reaction, reactor theory and diffusion theory.

Announcements

The Paris Academy of Sciences has elected Prof. D. Keilin, lately Quick professor of biology and director of the Molteno Institute, University of Cambridge, to be foreign associate; and Prof. H. Gaussen, professor of botany in the University of Toulouse, to be *correspondant* for the Section of Rural Economy.

Sir Gordon Radley, deputy director-general, and formerly engineer-in-chief, of the Post Office, has been appointed director-general in succession to Sir Alexander Little, who is retiring.

Dr. F. H. K. Green, principal medical officer on the headquarters staff of the Medical Research Council since 1949, has been appointed scientific secretary to the Trustees of the will of the late Sir Henry Wellcome (The Wellcome Trust, 24 Harley Street, London, W.1), with effect from October 1; he will accordingly leave the service of the Medical Research Council on September 30.

Mr. S. Culpin, director of Gleadthorpe Experimental Husbandry Farm, Welbeck Colliery Village, Mansfield, Notts, has been appointed director of the Experimental Husbandry Farm which is being established at Drayton in Warwickshire when this farm is taken over from the Grassland Research Station in September next.

The Documentation Committee set up by the Society of Chemical Industry in 1952 is publishing in *Chemistry and Industry* periodical lists of amendments to the third edition of the "World List of Scientific Periodicals", and three have so far appeared. They include certain amendments to library holdings after 1950. Details of any errors discovered in the lists should be sent to the honorary secretary of the Committee, Miss M. I. Wyatt, Laboratories, J. Lyons and Co., Ltd., 149 Hammersmith Road, London, W.14, from whom further information can be obtained.

The Admiralty is arranging a summer school for university and technical college teachers on scientific problems which arise at all stages in the development of electronic devices, to be held at the Services Electronics Research Laboratories, Baldock, Herts, and Harlow, Essex, during September 20–23. Leading scientific workers from industrial and government laboratories will discuss their problems, and practical demonstrations of modern valve and transistor development techniques will be given. Further information can be obtained from the Deputy Director of Physical Research (C.V.D.), Admiralty, 20 Great Smith Street, London, S.W.1.

In *Nature* of January 1, 1955, p. 26, reference was made to the work in the United States of the Animal Care Panel. We are informed that the Proceedings of the annual meetings of the Animal Care Panel can be purchased from the Secretary-Treasurer of the Animal Care Panel, Dr. Robert J. Flynn, P.O. Box 299, Lemont, Illinois, U.S.A., directly or through booksellers in the United Kingdom, at the following prices (plus postage): 1950, 1 dollar; 1953, 3 dollars; 1954, 4 dollars, or from the Laboratory Animals Bureau, M.R.C. Laboratories, Holly Hill, Hampstead, London, N.W.3, at the following prices (post paid within the U.K.): 1950, 7*s.* 9*d.*; 1953, 22*s.* 9*d.*; 1954, 30*s.* Proceedings for 1951 and 1952 are no longer available.

INTERNATIONAL CONFERENCE ON COAL SCIENCE

PROGRESS in the study of coals as chemical substances, and in the measurement of their intrinsic physical properties as distinct from mechanical characteristics, has been very slow. Coals form a well-defined family of organic substances with peculiar properties that differentiate them clearly from other natural products and render difficult their study by orthodox chemical methods. Throughout this century small groups of research workers have nevertheless attempted this task; and in the years immediately following the formation of the Coal Research Club by R. Lessing and R. V. Wheeler in 1921, it was possible for almost all relevant work to be discussed adequately between those principally involved. The situation has now changed radically. There has been an awakening of interest in many countries, stimulated partly by competition from other fuels and partly by the shortage of coals suitable for making metallurgical coke, a process basically dependent upon chemical properties. The development of team-work, resulting in a rapid increase in the volume of publications, has coincided with a decrease in opportunities for its wider discussion. While many of the older views on coal constitution have been confirmed in principle, definitely established facts date almost exclusively from the past decade or two. Concomitant with this increase in agreed knowledge, many apparently incompatible observations have been made, and the need for personal contact between workers in the field was never more evident.

Within the United States, this purpose has been admirably served by the residential Gordon Conferences on Coal, sponsored by the American Association for the Advancement of Science and occupying a full week in each year. The proceedings are, however, private, and European representatives are normally very few. After his return from America to Germany in 1949, Prof. W. Fuchs attempted to meet this need by inaugurating annual *Steinkohlentagungen* at Aachen, where he holds a chair of technical chemistry at the Technische Hochschule. The papers delivered, but not the discussions, were normally published in *Brennstoff Chemie*. These conferences proved most valuable, but a need was felt for placing them on a broader all-European basis. This feeling was given expression after the *Steinkohlentagung* of 1954 by the formation of an international Organizing Committee, with the following membership: Prof. D. W. van Krevelen, president (Netherlands); Dr. I. G. C. Dryden (Great Britain); Prof. W. Fuchs (Germany); M. E. H. Grand'ry (Belgium); M. R. Loison (France); Dr. M. Th. Mackowsky (Germany); and Dr. D. C. Rhys-Jones (Great Britain).

The first International Conference on Coal Science was accordingly held during May 2–3 at Heerlen in the Province of Limburg, Netherlands. It was attended by more than ninety participants from eight countries; interest in Great Britain was attested by the size of the British contingent, which numbered sixteen, and the United States was indirectly represented by two members of European Research Associates (Brussels), a branch of the Carbide and Carbon Chemicals Company. The town hall of Heerlen was placed at the disposal of the Conference, and the municipality gave every assistance to the organizers; at the conclusion of the official sessions, members of the Conference were offered hospitality by the burgomaster, Mr. M. F. G. M. van Grunsven.

On the morning of each day, general lectures each covering a definite field of coal science were delivered and discussed, and the afternoons were devoted to short communications covering special aspects of these fields. An attempt was made to restrict the subject-matter to coal science as distinct from coal technology; but even so a wide range of topics was covered. The theme on the first day was "The Genesis, Constitution and Properties of Coal" (chairmen, Dr. Rhys-Jones and M. Loison); on the second, "Carbonization and Coke Structure" (chairmen, Prof. Fuchs and M. Grand'ry). Discussion of the papers took place during the sessions and at an informal meeting on the evening of the first day.

Lignin is one of the chief materials from which coal has been formed by slow chemical and physical changes. Formation of lignin in the living plant, and its chemical constitution, were discussed by W. Fuchs, who pointed out the wide variety of related substances that can be included under this name. Fuchs also discussed the chemical conversion of lignins and other natural materials into coal, with special reference to his view that the 'redox' potential is an important determinant of the type of product; he adduced evidence suggesting that anaerobic conditions predominated during the early stage of formation of black or hard coal, aerobic conditions during that of brown coal. It is generally considered that the humic acids extractable from peat and humus by aqueous solutions of alkali are intermediates in the process of coal formation. The distribution of humic acids in low-rank coals was discussed by D. J. W. Kreulen, who showed that humic acid content does not necessarily decrease with increasing maturity of brown coals and lignites. Kreulen concluded that the formation of humic acids and the formation of coal are two independent processes; humic acid formation takes place only under conditions of oxidation, and coal can thus be formed either directly or *via* humic acids. It is likely that both processes usually occur simultaneously.

A. Gillet followed, by graphical methods, the changes in elementary composition in passing from plant constituents and peat to high-volatile bituminous coals, and suggested possible structural changes that might be involved.

Several different approaches to the study of the constitution of coal are possible: coal can be converted to simpler materials, for example by hydrogenation and oxidation, and these can then be examined in detail, or alternatively coal itself or primary derivatives such as solvent extracts may be studied directly. S. G. Ward submitted preliminary results of a comprehensive study of oxidized products, intermediate between humic acids and benzene carboxylic acids, produced by oxidizing humic acids with alkaline permanganate, with hydrogen peroxide and with ozone. The humic acids themselves were produced by alkaline permanganate oxidation of deep-mined coal or by alkaline extraction of outcrop coal. Fractions containing between ten and forty carbon atoms in the molecule were obtained by

various procedures, including chromatography and methylation; but none could be claimed as a single compound. J. P. Schuhmacher described the solvent fractionation and high-vacuum distillation of fractions obtained by hydrogenating coal in tetralin at 325° C. and 180 atm. The fractions were characterized by physical properties, chemical analyses, molecular weights and infra-red spectra. One of the objectives was the estimation of the mean number of fused aromatic rings in a molecule of product. The results suggested that some of the products were polymeric structures derived from monomers containing a phenanthrene nucleus. I. G. C. Dryden compared knowledge of coal structure derived from infra-red spectra with that from chemical group determinations, and described recent work in the British Coal Utilisation Research Association, in which the two techniques were used for supplementing one another. He showed that the presence, although not the precise amount, of phenolic hydroxyl in lower-rank British coals has now been definitely established by collaboration between W. F. Wyss, working on acetylation of coals, and J. K. Brown, working on the infra-red spectra of coals and their acetylated derivatives. Comparison was also made between the determinations by C. R. Kinney (Pennsylvania State University) of the amounts of acetic acid produced by different coals on oxidation, and the spectroscopic estimation by Brown of the proportion of aliphatic hydrocarbon groups in similar coals. J. Schuyer described the evidence for the existence in coal of what he termed 'complexes', namely, associations of molecules within which charge transfer can occur. A semi-quantitative discussion of this concept, in relation to the type and spacing of the lamellar molecules that are probably present and the semiconducting properties of anthracites, and to corresponding information derived from the molecular refractivities of coals, gave an encouraging measure of agreement. Only one paper dealt directly with physical properties: G. Heinze described comparisons between various forms of hardness test using continuous or alternating load. A correlation was found between micro and macro Vickers hardness.

On the second day, three papers dealt with aspects of the mechanism of plastic softening of coal, particularly during carbonization. This softening, accompanied by the development of a sticky consistency, is essential to the production of a strong large coke from small particles of coal. The ultra-fine porosity of coal particles is also relevant to its behaviour in carbonization; and mechanical aspects related to the physical effects accompanying the hardening of plastic coal to solid semi-coke, which have great influence on the crack structure and strength of the resulting coke, were also described. The physical examination of cokes by microscopy, other optical methods, and X-ray diffraction formed the theme of further papers; and finally, a test for the reactivity of high-temperature coke to carbon dioxide (an index of its behaviour in combustion and in metallurgical plant) was described.

The plastic softening of coal on heating was discussed at length by D. W. van Krevelen. Measurements of plastic and swelling behaviour were shown to be consistent with the hypothesis that a metastable liquid intermediate is first formed and afterwards decomposed. It was shown that small differences between the activation energies of these two consecutive pyrolytic reactions can account for many of the differences observed between coals. A mixture of a low-melting polymer, a substance yielding gas on thermal decomposition, and a condensing agent to promote further polymerization was found to simulate closely the carbonizing properties of a typical coking coal. D. FitzGerald described measurements with a Gieseler plastometer of the rate of hardening of plastic coal at constant temperature—that is, of the second stage of pyrolysis mentioned above—which he has fitted to a first-order reaction-rate equation, deriving velocity constants. Activation energies were almost independent of the rank (or maturity) of the coal tested; the values fell in a narrow range around 50 kcal./mole. It was also found that addition of a small amount of 9–10 dihydro-anthracene decreased the reaction velocity; it was suggested that decomposition of this additive released atomic hydrogen which retarded the cross-linking or hardening of the plastic coal. J. W. Phillips discussed plastic flow of coal at room temperature, which can be induced by briquetting and by other well-known techniques, and suggested that the behaviour of coal in this respect is analogous to that of any other brittle and extensively cracked material, and is not directly related to the plastic softening of coal on heating (which involves decomposition).

Coals have an extensive ultrafine porous structure and have been shown to behave as molecular sieves. A study of this aspect, using the measurements of heat of wetting, adsorption and apparent density as an indication of the extent of penetration of a given liquid into a coal particle, was described by R. L. Bond. The structure of bituminous coals is characterized by two modal sizes of constriction, both of the order of tens of angstroms, and this structure is rather surprisingly found to persist with relatively minor changes in dimension up to carbonization temperatures of 600° C. and above. Above 600° C. the structure is less apparent because it is penetrable only by very small molecules such as those of hydrogen and helium, and can only be studied by measurements of adsorption or apparent density. This fine structure is important in determining the ease of escape of volatile pyrolysis products and therefore the degree of their secondary decomposition; it also influences the extent of plasticization achieved by a given amount of fluid decomposition product.

The strength and size of a coke are important in relation to its use in blast furnaces and cupolas, where a heavy metallurgical burden has to be supported, and the voids must not be choked by degraded coke particles. These properties are influenced to an important extent by the fissuring that occurs during and after solidification of the plastic coal mass. Fissuring depends on the temperature gradient near the plastic zone in the coke oven, on the rate of hardening, on the temperature of hardening, and on several other factors. A. F. Boyer discussed the distinction between local mechanical properties of the coke and the strength of larger pieces containing fissures; a laboratory mechanical test depending on the curvature observed when a layer of coal is coked by heating from the underside was described; the microscopic observations of coke in polarized light were shown to emphasize heterogeneity of coke particles. Application of the many principles described to the practical improvement of coke prepared from given coals was then discussed: for example, the importance of the relationship between the temperature of maximum rate of decomposition and that

of solidification, and of the relative solidification temperatures of the constituents in blends of coal.

M. Th. Mackowsky illustrated the value of microscopic investigations in studies of coke structure and strength. Proof was adduced that the macropore system of cokes, which can be studied by this method, consists of intercommunicating chambers. B. Alpern also contributed to this subject, describing the use of microscopy in reflected polarized light in recognizing coke constituents of differing optical anisotropy. It was shown that different coals in blends do not mix intimately during carbonization. S. Durif compared cokes by X-ray diffraction measurement of the degree of graphitization after heating to 2,000° C.; many factors involved in its formation at lower temperatures were shown to affect this characteristic.

Finally, A. Dahme described a method of determining reactivity of coke to carbon dioxide in terms of the reaction velocity at 1,100° C. and the activation energy of the reaction. He showed that cokes differ in the relative extent to which reaction takes place on the outer surface of the particles and on the internal surface.

CONGRESS OF CELL BIOLOGY

THE Eighth International Congress for Cell Biology was held at Leyden in September 1954. It was organized by a Dutch Committee including Prof. J. Boeke as honorary president, Prof. P. J. Gaillard as president, Dr. W. K. H. Karstens and Dr. Johanna J. P. Zaaijer as secretaries. The Dutch Committee was acting on behalf of, and with the advice of, the International Society for Cell Biology.

As was the case with all the recent congresses in this field, the view was taken that cells constitute one of the definitive levels of organization of living matter and that, for the proper appreciation and discussion of cellular phenomena, all cellular and sub-cellular biological phenomena are relevant. Consequently the Congress covered a very wide field. The arrangements made by the organizers provided admirably for those who wished to obtain a general view of the field, as well as for those whose interests were more restricted. In the afternoons there were a number of parallel sessions, many of them symposia, which provided for detailed discussion in a wide variety of fields. It was, of course, impracticable to attend more than one of these sessions; but the common morning sessions were organized to enable all who wished to do so to obtain a bird's-eye view of many major fields. The morning lectures were upon the following topics: induced enzyme synthesis; intercellular substances; immunobiological concepts of growth and differentiation; biochemistry of gene action; virus synthesis; isolated mitochondria; phase-contrast microscopy; X-ray methods in histochemistry; microradiography; chromosome structure; thyroid secretion; morphogenetic interaction between cells; cell division and mitotic poisons; facilitated diffusion and active transport; electron microscopy of cells. On the whole this scheme worked well; but its success was limited by the failure of some of the lecturers to give broad surveys.

Scientifically, the chief value of the Congress lay partly in the general survey which was made of a large part of cell biology, and partly in the provision of ample time for informal discussion. One of the most valuable arrangements was the provision of discussion rooms to which any small group which arose spontaneously could resort to pursue any topic which it wished to consider. As regards subject-matter, perhaps the most striking feature was an indication that the gulf between the students of chromosome morphology and other cell biologists is beginning to narrow.

The able organization of the scientific aspects of the Congress was paralleled by the excellence of the social activities. The Congress was opened in the Pieterskirk by addresses from Prof. Gaillard, from the President of the Board of Curators and the Rector Magnificus of the University. One of the Dutch hosts remarked that the growth of fingers in tissue culture presented those interested in criminal law with some unusual problems. The president of the Society for Cell Biology, Prof. E. N. Harvey, was prevented from attending by illness; but his speech was read by Paul Weiss in a style which was widely appreciated. There were a number of other attractive social functions, of which the most outstanding was the reception given by the Netherlands Government in the Amsterdam Rijksmuseum. Here, in addition to the permanent collection, there was a remarkable exhibition of Indonesian art. From every point of view, the Dutch Committee succeeded in making the Congress an outstanding success.

The Congress was preceded by a meeting of the Cytochemistry Commission of the Society for Cell Biology. The Commission was established in 1950, by the Society, to accelerate the study of cytochemical techniques. The Commission held a meeting, lasting two days, in Prof. Gaillard's laboratory. Recent progress in cytochemical techniques for the study of nucleic acids, proteins, polysaccharides and various enzymes was reviewed. The Commission was able to report that much progress had been made since its first meeting (in 1951).

At the end of the Congress it was decided to accept an invitation to hold the Ninth Congress at the University of St. Andrews, Scotland. This will take place during August 28–September 3, 1957. The Executive Committee responsible for the Congress will include Dr. Honor B. Fell (*chairman*), Prof. H. G. Callan (*secretary*), Dr. Robert Brown and Prof. M. M. Swann. The following officers of the Society for Cell Biology were elected: *President*, Prof. P. J. Gaillard; *Past-President*, Prof. E. N. Harvey; *Vice-Presidents*, T. Caspersson, H. B. Fell, P. Weiss; *Secretary*, Prof. J. F. Danielli.

BRITISH GELATINE AND GLUE RESEARCH ASSOCIATION

RESEARCH PANEL MEETING

THE tenth meeting of the Research Panel of the British Gelatine and Glue Research Association was held on May 17, with Mr. S. G. Hudson (Richard Hodgson and Sons, Ltd.) in the chair. Two papers were presented, and at the close of the meeting those present visited the Association's laboratories at 2*a* Dalmeny Avenue, Holloway, London, N.7.

The first paper, "Recent Research on the Mechanism of Photographic Sensitivity", was given by Dr. J. W. Mitchell (H. H. Wills Physics Laboratory, University of Bristol). Dr. Mitchell described the recent series of experiments which he and his collaborators have carried out, aimed at providing definite experimental answers to many of the

speculations which have been put forward from time to time to account for the behaviour of silver halide emulsions. The most important step in this work has been the preparation and use of large single crystals of silver bromide in the form of thin parallel slabs. These can be obtained either strained or, by an annealing process, strain-free.

The results of sensitization by immersion in gelatin solutions, by digestion with gelatin solutions which could be modified by the addition of reducing substances, sulphur-containing sensitizers and potassium chloro-iridite, were described. Chemical sensitization appears to arise from silver, gold or silver sulphide produced at strained or roughened regions on the surfaces of the crystals. By direct deposition of silver and gold on the surfaces, it was possible to check this view, and silver films could also be converted to silver sulphide. On exposure of silver bromide to light, halogen atoms are released, and chemical sensitizers function by reaction with the released halogen. The recent results have brought into prominence some of the older theories of sensitivity. A lively discussion, opened by Mr. R. C. M. Smith (Ilford, Ltd.), followed the paper, and gave Dr. Mitchell the opportunity to expand his account of certain aspects of the work.

The second paper, given by Dr. C. H. Bamford (Courtaulds Fundamental Research Laboratory, Maidenhead), was on "Synthetic Polypeptides", and in it the work which has been carried out at Maidenhead was reviewed and related to the behaviour of proteins. The configuration of polypeptide chains can be examined by such physical methods as absorption of polarized infra-red radiation, which enables the directions of the —NH and —CO groups to be determined, by X-ray diffraction spectra, where certain polypeptides give results in close agreement with those to be expected for the 3·7 helical structures proposed by Pauling, and by optical rotation. Synthetic polypeptides occur in two configurations: α, referred to above, with intrachain hydrogen bonding; and β, an extended form with interchain hydrogen bonding. These correspond closely with structures found for natural proteins such as keratin and silk; but an analogue for collagen has not been found yet. The discussion on this paper was opened by Mr. A. G. Ward (British Gelatine and Glue Research Association).

A. G. Ward

WATER POLLUTION RESEARCH IN BRITAIN

To those whose work or interest lies in river pollution prevention, water treatment, and sewage and trade wastes purification, the study of the annual reports of the Water Pollution Research Board and of the Director of Research is at once a necessity and a pleasure. The report for 1954* easily maintains the interest and information that have characterized previous reports.

A notable event of the year was the completion and occupation of the new laboratories at Stevenage, Hertfordshire, which now house all the staff who were previously working at Watford, Garston, Birmingham, Coventry and Tilbury. Thus for the first time since the formation of the organization in 1927, all the staff are together in one building—a great advantage for future work. The new laboratories have a number of novel features; among the many facilities may be instanced a small pumping station, which can deliver up to 50,000 gallons of sewage daily to experimental plant (see also *Nature*, June 25, p. 1105).

The largest section of the report comprises an account of the progress made in the complex survey of the Thames Estuary. Here it was found necessary to undertake the fundamental task of redetermining the values of the solubility of oxygen in water, over a range of temperatures and salinities, in equilibrium with moist air of normal composition at sea-level. The values so obtained were found to be 3–4 per cent lower than those commonly accepted hitherto. Part of this work involved the checking of the well-known Winkler titrimetric method for the determination of dissolved oxygen against a reference gasometric method, establishing that the former is without appreciable error. Other studies included a statistical examination of the chemical records of the London County Council concerning the condition of the Thames, and the factors controlling the balance of oxygen in the estuary water—that is to say, the amount of fresh water entering at Teddington, the absorption of oxygen from the atmosphere under various surface conditions, the effect of synthetic detergents upon the absorption and the rate of oxidation of polluting matter, including the effect of bottom deposits removed by dredging. Both field-investigations and laboratory experiments have now been terminated; but the final conclusions await the completion of the many lengthy calculations that have to be made.

A further section of the report deals with the effects of pollution on fish. The Laboratory has assisted the Ministry of Agriculture and Fisheries in a survey of the River Colne, principally regarding the effect of sewage effluent upon fish life. Laboratory experiments are being continued on the degree of toxicity of ammonia, carbon dioxide and synthetic detergents. It appears that the degree of toxicity is frequently related to the amount of dissolved oxygen present—fish can survive doses of toxic substances in well-aerated water that would be fatal in poorly oxygenated water.

In the section on sewage, an account is given of the examination of surface run-off water from a housing estate, the conclusion being that this water was not of a very polluting nature apart from its rather high content of suspended solids. The biological filtration of sewage is discussed as regards periodicity of dosing and efficiency of filters, and also the work so far done on the effect of synthetic detergents upon sewage treatment, where quantitative information on the subject is by no means abundant.

A useful piece of work has been done in conjunction with the Government Laboratory: that of reviewing methods for determining concentrations of various metals in waste waters and effluents down to 0·1 p.p.m. The methods suggested are due to be incorporated in the second edition of "Methods of Chemical Analysis as Applied to Sewage and Sewage Effluents" to be published by the Ministry of Housing and Local Government.

Investigations have been continued concerning the removal of cyanides from industrial waste waters by biological filtration; the organism responsible has been isolated and described. Biological destruction of cyanide in mixed plating wastes has been shown to be a practical method for dealing with such

* Department of Scientific and Industrial Research. Report of the Water Pollution Research Board, with the Report of the Director of Water Pollution Research for the year 1954. Pp. vi+65+4 plates. (London: H.M. Stationery Office, 1955.) 3s. net.

wastes, and if the information resulting from this research is properly acted upon by the industries concerned, a potent source of pollution will be greatly reduced. Experiments on the anaerobic digestion of partially neutralized waste liquor from the kiering of cotton were also continued. This method of treatment is a possible one for pre-treatment before discharge to a public sewer, having the merit first of requiring less space than a percolating filter to effect the same degree of improvement, and secondly of the ability to treat undiluted kier liquor, whereas for a percolating filter the liquor would require considerable dilution.

The section on water is very brief. Experiments are described on the removal of fluoride from water by passage through a column of activated alumina. The reason for the complete blockage of two slow sand-filters was investigated and found to be due to deposited crystals of calcium carbonate which had bound the sand grains together, the deposit having been induced by loss of carbon dioxide from the water during previous aeration.

Lastly the report emphasizes that an important part of the Laboratory's activities is now concerned with the development of automatic equipment. A noteworthy achievement has been the production of an instrument for the continuous recording of the dissolved oxygen content of a stream of water, thus giving valuable information about fluctuations that would usually be missed by the methods of intermittent sampling that otherwise have to be employed.

STANFORD RESEARCH INSTITUTE, CALIFORNIA

REPORT FOR 1954

THE annual report for 1954 of the Stanford Research Institute, California*, records an increase of 242 in the staff during the year, and, of these, 165 have professional training and five to ten years of industrial experience. The staff now totals 916, and the revenue has increased by 40 per cent to 7·57 million dollars. Contract research is now being conducted at the rate of 8·5 million dollars a year, and the number of research projects has increased from 382 to 478, of which 297 were for private business, 128 for the Government and 53 were sponsored by the Institute as part of its plan for aiding the technological and economic development of the western part of the United States. In terms of dollars, the ratio of commercial projects to government projects was 54 : 46—an almost exact reversal of the ratio in 1953.

The 53 public service projects include studies of air pollution and high-temperature materials, of industrial water resources in California and of surface tension in solids; research on human engineering in industry; the effect of γ-radiation on high polymers; a survey of industrial land use in the Portland area; and the production of such reference works as the "Western Resources Handbook", "The Chemical Economics Handbook" and "The Directory of Western Chemical Producers". The Institute also sponsored symposia on the automatic production of electronic equipment, on social science for industry and on area development problems.

* Stanford Research Institute: Annual Report for 1954. Pp. 48. (Stanford, Calif.: Stanford Research Institute, 1955.)

In the Engineering Division electronics claims the largest share of attention, particularly the theoretical analysis of antenna systems, the design and manufacture of prototypes and the performance of radiation systems. The Physical Sciences Division has dealt with the production of chemicals from petroleum, utilization of wood waste, tallow, bagasse and fish waste, as well as the properties and applications of polymers, the storage and utilization of solar energy, the effect of infra-red radiation on chemical reactions, the use and control of sound waves and with the weapons-effect programme. The Division is also engaged in biochemical research and on problems in nutrition, microbiology, physiology and toxicology, while expansion into pharmacology is in progress. The Economics Division is concerned with three broad categories of work: the economic analysis of problems for specific companies; the examination of specific functions, such as the application of electronic data-handling equipment to accounting and clerical operations, the application of operational research in management and the industrial application of social science; and the use of economic surveys in area development, including also the location and protection of plant, military logistics and weapons-system evaluation.

In the Poulter Laboratories contributions have been made to the understanding of shock waves and detonations which have increased the effectiveness of explosives both for military purposes and in mining, agriculture and demolition. The Institute's work on defence against nuclear bombs has shown that earth-covered steel-arch structures above ground provide a significant level of protection at economical cost; but that most ordinary structures not specifically designed for the purpose are not significantly strengthened against blast by earth cover. Work on rocket liners has shown that detonation in tubes can be limited by absorbing compression-wave energy at the walls and, in work on graphite nozzles for liquid fuel rockets, a new technique for converting graphite to metallic carbide for an appreciable depth has given promise. A non-destructive test device, called a stub meter, for the plastic-adhesive bonded sandwich has been developed by the Institute physicists. Ten common weeds, grown under controlled conditions, have now been standardized as indicators of atmospheric pollution by hydrogen fluoride, sulphur dioxide, hydrogen sulphide, ammonia, chlorine and oxides of nitrogen. Under a project sponsored by the Southern Pacific Co., the hydrofriction system for freight cars has been developed to distribute the impact of energy more evenly or at a more constant rate by new shock-absorbing mechanisms.

METABOLISM OF RADIOACTIVE SUGARS

H. K. PORTER and L. H. May have followed the uptake and utilization of radioactive sugars by tobacco leaf disks (*J. Exp. Bot.*, 6, 16, 43; 1955). When destarched tobacco-leaf disks were floated on 5 per cent (w/v) solutions of sucrose uniformly labelled with carbon-14 in either the glucose or fructose moiety, and on invert sugar in which one hexose only was so labelled, in an atmosphere of oxygen at 25° C., seventy-five per cent of the sugar lost from the external solutions was recovered as starch, sucrose, fructose, glucose and carbon dioxide.

With sucrose as the substrate, 30 per cent of the material was recovered as carbon dioxide, and 17 per cent each as starch, sucrose, fructose and glucose. With invert sugar as the substrate, 30 per cent was again recovered as carbon dioxide, only 20 per cent as the three sugars together, and 50 per cent as starch.

Whichever hexose was initially labelled and whether the sugar was supplied as sucrose or hexose, the relative specific activities of starch and sucrose in the leaf disks and of the carbon dioxide evolved were equal or nearly equal to that of the sugar supplied.

With sucrose as the substrate the sucrose in the disks retained its asymmetry of label, and free hexoses produced were similarly asymmetrically labelled. When invert sugar was the substrate, the sucrose synthesized was strongly labelled in both moieties, as also were the free hexoses.

It is concluded that fructose and glucose free or combined in sucrose were equally available for starch synthesis and carbon dioxide formation, and that there can be no question of preferential utilization of one or other hexose. Starch and carbon dioxide must arise from a common source in which readily formed derivatives of the hexoses are rapidly equilibrated. Free hexose cannot participate directly in either sucrose or starch synthesis. Accumulation of sugar not immediately metabolized and inversion of sucrose take place at a site remote from the common pool.

MARINE BIOLOGICAL RESEARCH

THE first number of Vol. 34 of the *Journal of the Marine Biological Association of the United Kingdom* contains ten papers on a variety of marine topics. It commences with an obituary notice of one to whom marine biology owes a very great deal, the late Dr. George Parker Bidder, who died in his ninety-first year last December; he was the last of those connected with the early development and struggle for existence of the Marine Biological Association and its first honorary member. There is a characteristic photograph of him as frontispiece.

In the first of the ten papers, Dr. John R. Baker, working under the auspices of the Universities' Federation for Animal Welfare, describes a method for the humane killing of crabs by piercing the brain with an awl through the sternum of the segment of the first antenna and the ventral nerve mass through the depression at the posterior end of the sternum of the chela-bearing segment. The method can be learned quickly by the fishmonger and canner, and avoids autotomy of the appendages.

Dr. H. A. Cole and Mr. D. A. Hancock record the presence of a small parasitic gastropod in oysters from the River Colne in Essex, *Odostomia eulimoides*, formerly known only from *Pecten maximus* and *Chlamys opercularis*. *Odostomia* attacks the mantle edge of the oyster, causing the formation of a mantle pocket, later of a shell pocket, with thickening of the mantle and shell substance over the pocket, the malformation being visible externally. In severe cases, involving the presence of a number of parasites, the irritation may spread inwards to the adductor muscle, and the deposition of brown shell material on this muscle causes the shell to gape, with resulting suffocation and death. The parasite occurs in the River Crouch in considerable numbers, in other rivers of Essex, and also at Salcombe, Devon, where *Chrysallida obtusa* Brown is here recorded for the first time in oysters. In North Wales, Dr. Knight Jones found *Odostomia scalaris* in mussels. No methods of control are known.

A detailed account of feeding and digestion in terebellids, with special reference to *Amphitrite johnstoni*, and a comparison between this and other members of the family are given by Dr. R. Phillips Dales. Food is collected by ciliary action along the groove on each of the tentacles and, wrapped in mucus, is conveyed to the lips and thence, by an elaborate series of rolling movements, to the mouth. Strong amylase activity, weak protease and lipase activity occur in the fore-stomach, strong enzyme secretion of all three in the fore-intestine and, between the two, mixing of the food by muscular action of the hind-stomach. Absorption takes place in the fore-intestine and anterior part of the hind-intestine. While the structure of the gut and the digestive process are similar in all terebellids, the lips and feeding habits vary in different genera.

Dr. J. E. Morton and Dr. N. A. Holme record the discovery of large numbers of the tectibranch *Akera bullata* in a sea-water tank in the Naval Dockyard at Devonport, the first record for the Plymouth area. The animals were feeding on the thick growth of green algae growing on the sides of the tank and were breeding freely, the majority, however, dying after spawning. A study of its structure leads the authors to the conclusion that *Akera* ought to be removed from the Bullomorpha and placed in the Aplysiomorpha. A good account is given of its swimming habits, with outline diagrams based on a film of the living animal taken by Mr. F. A. J. Armstrong, and Dr. D. P. Wilson adds beautiful photographs of this marine 'ballet dancer'. Dr. Morton also contributes a paper on the structure and ecology of the minute marine pulmonate, *Otina otis*. This limpet-like form lives in the barnacle zone, browsing on small algae, and breathes through the lateral lobes of the foot, for the pallial cavity is very narrow and not specialized for respiration. Few of the characters of *Otina* are specialized; but most, particularly those of the digestive, genital and nervous systems, are primitive.

Dr. R. B. Clark and Dr. A. Milne have worked on the sublittoral bottom fauna of two sandy bays on the Isle of Cumbrae, using the Robertson mud bucket. Their studies were chiefly on polychaetes, molluscs, echinoderms and crustaceans. Few species in this area are gregarious; random distribution is the general rule in the bottom community. Drs. L. R. Fisher, S. K. Kon and S. Y. Thompson contribute their third study of vitamin A and carotenoids in invertebrates, and are here dealing with eleven species of euphausiids. There is considerable variation in the amount of vitamin A stored in the eyes. One small-eyed species, *Thysanopoda acutifrons*, is peculiar in having none. Neritic groups of *Meganyctiphanes norvegica* have higher reserves than those from the open Atlantic; but the fat concentration is highest in northern waters. Astaxanthin is found in all. It is significant that, despite their similar habitat, the euphausiids are biochemically and morphologically distinct from the Mysidacea, and in both respects appear to be related to the Penaeidea. Euphausiids form a link in the food-chains leading to blue and fin whales, sperm and bottle-nosed whales (through decapod cephalopods), herring, cod (at certain times of the year) and halibut. Dr. J. S. Alexandrowicz

has extended his study of the innervation of the heart in Crustacea to that of *Praunus*. The three systems of nerve elements—intrinsic neurones (six in *Praunus*), a pair of nerves joining the local system to the central nervous system, and nerves to the arterial valves—are represented.

The salinity of Kames Bay sand, Isle of Cumbrae, with special reference to the distribution of *Nereis diversicolor*, has been investigated by Dr. Ralph I. Smith, of the University of California, Berkeley. He found a zone of relatively stable brackish interstitial water, and the zonation of the polychaete corresponds to this belt of lowered salinity. Whether it prefers the lowered salinity, or whether other competitive intertidal species shun it, is not yet clear; but Dr. Vera Fretter, working on the same species at Plymouth, shows that it can adjust itself gradually to the more dilute sea water and can maintain a steady state indefinitely. This it does by taking up water and losing salts. It achieves equilibrium in normal sea water, but is hypertonic in less salt water. Employing the tracer element sodium-24 obtained from the Atomic Energy Research Establishment, Harwell, she found that in sea water of 35 per mille salinity, saturated with oxygen, at normal atmospheric pressure and a temperature of 14° C., the *Nereis* was in equilibrium, and the uptake of sodium averaged 250 mgm./hr./gm. wet weight. At half salinity, after accommodation to the dilution, the uptake averaged 160 mgm./hr./gm. wet weight, and at 9 per mille it was 180 mgm./hr./gm., there being an active uptake of salts in this last-named case against the concentration gradient. Oxygen deficiency and temperature changes also affect the rate of uptake of sodium. The integument of *Perinereis cultrifera* is more freely permeable to ions than that of *Nereis diversicolor*, the influx of sodium being about three times greater in normal sea water.

The number under review concludes with abstracts of memoirs recording work done at the Plymouth Laboratory of the Association and published in other journals.

N. B. EALES

ISOTOPIC COMPOSITION OF METEORITIC HYDROGEN

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THE deuterium–protium ratio in meteorites is of interest because it is one of few known sources of information about the ratio of these isotopes in space near the time of formation of our planetary system. Their abundances in the sun's atmosphere are calculated from spectrographic measurements; but it is well known that at the sun's temperature deuterium is much more reactive in the nuclear process than hydrogen, and consequently there is extreme depletion of the deuterium as compared to the amount present in space.

The stony meteorites are too porous to retain a representative specimen of hydrogen gas, and if combined hydrogen is present it could rather easily be exchanged with hydrogen from water on the earth's surface after the fall. It appeared possible that hydrogen representative of that in planetary space might be retained in the carbonaceous chondrites (a small group of meteorites—twenty-one known, which contain varying amounts of free carbon and organic matter), and an investigation of the deuterium–protium ratio in this group of meteorites was carried out by G. Boato[1]. Previously, I. Friedman[2] conducted an isotopic analysis of an iron meteorite (Canyon Diablo); but stressed that some fractionation may have occurred during the process of outgassing the sample.

In 1953, I described[3] experiments on the isolation and determination of protium and deuterium in iron meteorites and presented results for two meteorites. Since then a number of other meteorites have been examined by the same method.

The metal is oxidized by heating to 1,100° C. in a stream of pure oxygen gas, the water from hydrogen in the meteorite being collected in a cold trap at −70° C. When the oxidation is complete, any carbon dioxide in the cold trap is pumped away. The temperature of the trap is raised, and the water vapour is passed over zinc granules at 400° C. to regenerate hydrogen. The apparatus is so arranged that any unreacted water may be recycled and complete reaction assured. The hydrogen is compressed with a Tœpler pump and its volume measured before isotopic analysis.

To obtain oxygen of the necessary purity for the oxidation, it is passed over a mixture of copper oxide and palladium asbestos at 700° C., the oxidized products of hydrogen-containing compounds being adsorbed on active charcoal at −135° C.

The isotopic composition is measured with a 6-in. radius 60°-deflexion mass spectrometer of the double collector type similar to that described by Nier[4]. The instrument is equipped with two capillary leaks and with magnetically operated valves permitting rapid change-over of the sample and a standard gas (see McKinney *et al.*[5]). Results are expressed as differences, δD per cent, between the deuterium concentration in the sample and standard. The relation between this difference and the absolute ratio is expressed by the equation

$$\delta D \text{ per cent} = \frac{D/H \text{ sample} - D/H \text{ standard}}{D/H \text{ standard}} \times 100$$

and the standard gas is hydrogen of Lake Michigan water, the absolute ratio of deuterium to hydrogen, D/H, being approximately 1/6,500. Compared to this standard, average sea water is + 4·5 per cent. The error in analysis (including deviations introduced during the conversion of water to hydrogen) is ± 0·4 per cent maximum. The results of the analysis of a number of iron meteorites are shown in Table 1.

Meteorites were prepared for analysis as follows. With a diamond wheel in a dental drill apparatus, superficial rust was removed. Where sufficient rust was available, it was collected and the deuterium and protium determined in exactly the same way as for the meteorites. Final traces of rust were removed by sandblasting, after which the metal was washed with carbon tetrachloride. The meteorite was placed in a surface-grinding machine and dry-ground until no original surface metal remained and the specimen was rectangular in form. The meteorite was again washed in carbon tetrachloride and transferred with forceps to a shaping machine where the metal was cut to suitably sized swarf. All parts of the shaping machine around the meteorite were shrouded in

Table 1

Name	Class	Hydrogen (p.p.m.)		δD per cent (average)	
Coahuila	*H*	0·7		—	
Charcas	*Om*	3·5			− 8·5
Canyon Diablo	*Og*	4·4 5·5 4·8	4·9	− 7·4 − 8·7 − 8·1	− 8·1
Staunton	*Om*	5·2			− 8·2
Thunda	*Om*	6·0		—	
Bethany	*Of*	6·9			− 9·7
Cranbourne	*Og*	7·0			− 4·4
Carbo	*Om*	9·3			− 6·9
Tamarugal	*Om*	9·9			− 8·1
Arispe	*Ogg*	9·9			− 9·7
Cape York	*Om*	25·4			− 13·4
Henbury	*Om*	28·3 28·9 29·3	28·8	− 9·1 − 8·5 − 10·6	− 9·4
Cosby's Creek	*Og*	33·4			− 9·7
Toluca	*Om*	18·0 29·8 54·4	33·1*	− 9·6 − 5·1 − 9·6	− 7·1
Mild Steel		3·9 3·5 3·7 3·8	3·7	47·5 52·5 47·5 45·8	48·3
Average of meteorites					− 8·6

* Weighted average, see text

heavy aluminium foil which was previously washed with carbon tetrachloride. When about 10 gm. of metal had been cut, *all* cuttings were transferred to a clean bottle. If enough meteorite was available, the cutting process was repeated until a number of samples had been obtained.

During the cutting process, the turnings break into chips because of imperfections in the main body of the meteorite, and dark-coloured dust-like solid separates from the chips and falls to the bottom of the sample bottle. To obtain a representative sample of the whole meteorite it is necessary to collect the cuttings batch-wise as described, and to oxidize each sample as a whole.

In the case of Toluca, this was not done. All the cuttings were collected in a single bottle (26·9 gm.). The individual analyses of Toluca are shown in order in Table 1. The first two analyses are of 10-gm. lots of the turnings and the last analysis is of the 6·9-gm. residue in the sample bottle. It is apparent that the hydrogen is concentrated in the fine solid at the bottom of the same bottle. The difference in the deuterium analysis is not understood.

Table 2 shows the deuterium–protium analysis of surface rust from the meteorites from which a suitable sample was obtained.

It is clear that in general the hydrogen from the rust contains a distinctly higher proportion of deuterium than that in the metal. This, coupled with the fact that extreme care was taken to remove all rust—and, in fact, all superficial metal to an average depth of about 2 mm.—gives fair reason for believing the hydrogen from the samples to be that originally incorporated during the formation of the meteorites. It may be surmised that the hydrogen has been retained in the meteorite since it solidified and is representative of that in the parent body, at the time of solidification of the iron. It seems probable that the stony meteorites and irons were originally part of asteroids and that it was within such bodies that the separation of the phases occurred[6]. The age of two stony meteorites from recent argon–potassium measurements (Wasserburg and Hayden[7]) was found to be $4{\cdot}7 \times 10^9$ years. This age is that of the solidification of the silicate, and it is probable that the iron also solidified about the same time, and that the hydrogen is of about this age. It is possible that the irons are in two groups with hydrogen contents of 0–10 and 25 p.p.m. (Table 1), although many more analyses would be necessary to establish this fully.

The amount of hydrogen found in irons is surprisingly high. The solubility of hydrogen at the melting point of iron is about 0·8 p.p.m. The hydrogen in the iron meteorites is therefore not simply that in solution in the metal. It would appear that the hydrogen is contained in solids which are present in the minute irregular discontinuities throughout all the octahedrites examined. The experiments with Toluca meteorite suggest this. The substance in these discontinuities is thought to be sulphide and silicate not completely removed during the original separation of the iron in the parent body, together with some carbides. It may be that this substance also contains the large proportion of the uranium found in iron meteorites by Prof. Paneth and his co-workers[8]. Urey[9] has directed attention to the fact that the quantities of uranium found in the iron meteorites are distinctly higher than would be suggested from thermodynamic considerations of the distribution of uranium between metallic and oxide or silicate phases. Mr. O. Joensuu recently carried out spectrographic analysis of dust from fissures in Canyon Diablo meteorite, comparing this with metal chips from the same specimen. (The two can be separated moderately well by simply screening the whole sample of cut meteorite as it is obtained from the shaping machine.) He found 10 p.p.m. titanium in the metal and 300 p.p.m. in the fissure material. Uranium is not sufficiently abundant to permit spectrographic estimation, but would be expected to distribute itself between a metallic and oxide or sulphide phase in the same way as titanium[9].

In his study of deuterium in the carbonaceous chondrites, Boato[1b] attached special significance to the three results in which he found deuterium to be more than 25 per cent higher than in Lake Michigan water on the basis that such compositions lie outside the range of natural waters at present known. Since these experiments were made, a number of other facts have come to light which make this evidence less conclusive than was at first thought.

At the time of Dr. Boato's measurements, there was reason to believe that the carbonaceous chondrites might be the most primordial material of all the meteorites. Since then, Dr. Harold C. Urey and I have developed a method of measuring the concentration of certain minor elements in meteorites with a higher precision than was previously possible[10], and have estimated the sodium and potassium in carbonaceous and other chondrites. We have found a relatively great variation in the sodium and potassium in the carbonaceous chondrites. Dr. H. B. Wiik (private communication) has found this to be true for many other constituents also. We conclude that the carbonaceous chondrites have undergone chemical and/or thermal treatment at least as drastic

Table 2. Deuterium Concentration in Hydrogen from Rust on Meteorites

Name	Hydrogen content (p.p.m.)	δD per cent
Arispe	14,600	− 13·9
Coahuila	5,300	− 14·3
Cranbourne	11,500	− 11·9
Mount Joy	19,700	− 15·3
Staunton	12,400	− 13·3
Average		− 13·7

Table 3

Name	Total water (Wiik)	Total water (Boato)	Deuterium (δD per cent) Boato
Orgueil	19·7	11·0	29·0
Ivuna	18·6	12·0	35·0
Haripura	13·7	9·0	− 3·3
Meghei	12·7	11·0	− 5·8
Nawapali	16·4	12·0	− 7·2
Santa Cruz	12·1	10·0	− 0·7
Bokkeveld	15·1	10·5	− 13·0
Murray	12·4	9·0	9·6
Mokoia	2·0	1·1	25·0
Indarch	1·1	1·0	− 10·7

as that involved in the production of any of the other groups of meteorites, and that the carbonaceous chondrites have a much more complex history than we would expect of truly primordial material. The unexpected variability in this group of meteorites leaves us in great doubt at the moment, not only about the place but also the time of origin of these. Under these conditions it becomes difficult to attach special significance to specific results.

In the course of complete analysis of the carbonaceous chondrites, Dr. Wiik has determined the total water content, and I am greatly indebted to him for permission to quote his results prior to publication. As shown in Table 3, his values are consistently higher than those found by Dr. Boato. The reason for the divergence is not understood. There may be some significance in the fact that the greatest fractional divergence in water contents is associated with the deuterium concentrations more than 25 per cent higher than that of Lake Michigan water and to which Dr. Boato attaches greatest significance. J. Godfrey[11] has recently observed that when water of hydrated silicates is incompletely extracted, the deuterium is concentrated in the extracted water and *not* in the silicate, as would be expected in a simple vaporization process. It appears possible, then, that the high deuterium values obtained in Dr. Boato's experiments might be wholly or partly due to incomplete extraction, though it is difficult to see how this could have occurred.

In view of the variable composition of the carbonaceous chondrites and the doubt regarding their history and origin, there does not seem to be any simple way of weighting the results. Seven of the ten results have deuterium concentrations (δD per cent) grouped between − 13·0 and + 9·6 (average − 4·7 per cent), and the average of all the values is + 5·8 per cent with respect to Lake Michigan water (+ 1·3 per cent with respect to average sea water).

In these circumstances it appears that the deuterium–protium ratio found in the iron meteorites (− 8·4 per cent with respect to Lake Michigan water or − 12·9 per cent compared to average sea water) may be the most reliable available to us. The comparative consistency of the isotopic composition of hydrogen in the iron meteorites is suggestive of a common origin, different from that which gave rise to the surface rust. If we now suppose that the hydrogen of the iron meteorites is representative of that at or about the time of the earth's formation, then the present oceans are somewhat more abundant in deuterium than the primordial water. This is what we should expect if the earth had at some time lost all its original water except that remaining in hydrated silicates, and that the present oceans represent water evolved from these silicates. Incompleteness of this process of ocean formation would give water enriched in deuterium with respect to that in primordial water, as we indeed find.

I am indebted to Mrs. Jeanne Ingersoll for her assistance in all the practical work reported. My thanks are due also to Dr. Wiik for permission to use his results prior to publication, to Mr. O. Joensuu for spectrographic analysis, and to Prof. Harold C. Urey for useful discussions, advice and helpful criticism.

[Feb. 4

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CYTOCHROMES OF MICROSOMAL PARTICLES

Cytochrome b_5 of Microsomes from Animal Tissues

A HÆMOCHROMOGEN, showing absorption bands at about 552 and 525 mμ, was observed in 1951 in microsomal particles from cow's milk[1,2]. As part of a general programme of investigation of the nature and properties of microsomal particles, this hæmochromogen has now been studied in greater detail in microsomes, isolated essentially as previously described[2,3], from the mammary gland and milk of the same cow and from calf intestinal mucosa.

Thick pastes of the buff-coloured microsomes from mammary gland and intestinal mucosa show no absorption bands in the visible region when observed with a low-dispersion micro-spectroscope. After reduction with sodium dithionite, strong absorption bands appear in both preparations at about 560 and 525 mμ, as measured with a Hartridge reversion spectroscope. The pink-coloured microsomes as isolated from milk[2] show weak absorption bands in approximately the same positions, and these are only slightly intensified on addition of sodium dithionite. The lower readings previously reported[1,2] for the α-band may have been due to the presence of some adsorbed cytochrome *c* in the original preparation of milk microsomes.

The identity of the pyridine-hæmochromogen of the microsomal pigment with that formed from pure protohæm indicates that protohæm is the prosthetic group. This observation, together with the similarity in the positions of the visible absorption bands with those of cytochromes *b*, b_2 and b_3, which were simultaneously being studied in this laboratory, led us in 1953 to designate the microsomal hæmochromogen as cytochrome b_5[4]. (The normal sequence in the nomenclature of cytochromes of the *b* group was interrupted when the term 'cytochrome b_4' was given to a bacterial pigment[5] which appears to be

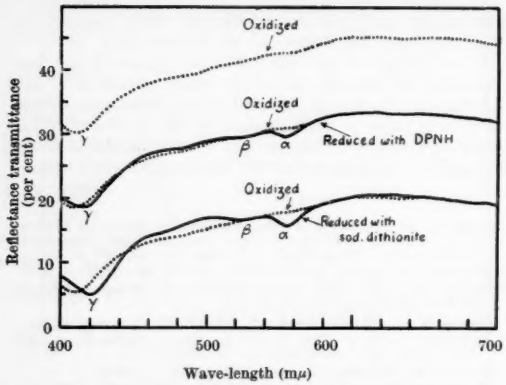

Fig. 1. Absorption spectrum of reflected light from a thick paste of microsomes from mammary gland

more closely related to cytochrome *c* than to cytochrome *b*. A component of plant chloroplasts has now been described as cytochrome b_6 [6].)

Using a specially designed recording spectrophotometer, Dr. F. Moss and Dr. R. G. Giovanelli kindly analysed the spectrum of the reflected light from mammary gland microsomes, as shown in Fig. 1. The bands of cytochrome b_5 appear as follows: oxidized, general absorption about 555 mμ and Soret at 412 mμ; reduced, 557 mμ (α), 526 mμ (β) and 421 mμ (γ or Soret).

In 1951 Kun[7] isolated from rat liver a pigment closely resembling cytochrome b_5 in absorption spectrum and showed that it was partly reduced by reduced coenzymes I and II (reduced di- and triphosphopyridine nucleotide). The relationship of cytochrome b_5 to the oxidases of these coenzymes and to their cytochrome *c* reductase activities of microsomes was therefore examined.

When about 0·5 μmole of reduced coenzyme I or II is added to about 0·5 ml. of a thick suspension of mammary gland or intestinal microsomes, the α- and β-bands of reduced cytochrome b_5 immediately appear. They rapidly disappear in the presence of air due to oxidation, but reappear on addition of further substrate. The process may be repeated several times. If oxygen is excluded from the system, the cytochrome remains reduced. Fig. 1 shows that, under aerobic conditions, cytochrome b_5 is only partly reduced by excess reduced coenzyme I, thus indicating the rapid oxidation of the reduced cytochrome by oxygen, possibly due to enzymic catalysis. Oxidation of reduced cytochrome b_5 is not inhibited by potassium cyanide (10^{-3} *M*).

The addition of oxidized cytochrome *c* to microsomes reduced with reduced coenzyme I causes an immediate reduction of the cytochrome *c*. Thus reduced cytochrome b_5 reacts, directly or indirectly, with either cytochrome *c* or oxygen. Table 1 shows that the reduced coenzyme I–cytochrome *c* reductase activity of milk, mammary gland and intestinal microsomes is closely related to the concentration of cytochrome b_5. Incubation of microsomes from mammary gland in milk serum at 38° for 10 hr. causes a marked fall in the reductase activity to that typical of the microsomes from milk. There appears to be a corresponding decline in the cytochrome b_5 concentration. The rates of reactions with reduced coenzymes I and II as substrates are substantially the same in intestinal, and presumably also in gland, microsomes. As shown in Table 2, the reduced coenzyme I–cytochrome *c* reductase activity of microsomes is only slightly inhibited by antimycin *A*.

Intestinal microsomes show a significant cytochrome *c* oxidase activity which is almost completely inhibited by 10^{-3} *M* potassium cyanide (Table 2). The dithionite-reduced microsomes show a very weak absorption band at approximately 604 mμ, presumably due to cytochromes $a + a_3$, but they have almost negligible succinic dehydrogenase activity. The presence of cytochrome *c* oxidase implies a cyanide-sensitive reduced coenzyme I–oxidase system. However, no cytochrome *c* could be detected spectroscopically in either mammary gland or intestinal microsomes. The cyanide-resistant cytochrome b_5 oxidase system may provide an alternative pathway from the cytochrome *c* oxidase, leading to production of energy for synthetic processes catalysed by microsomes.

These results indicate that cytochrome b_5 is intimately associated with the reduced coenzyme I (and II)–cytochrome *c* reductase and reduced coenzyme I (and II)–oxidase activities of microsomes. In this laboratory it has already been shown that crystalline cytochrome b_5 from yeast is a flavohæmoprotein having lactic dehydrogenase activity[8]. Cytochrome b_5 appears to bear a similar relationship to reduced coenzyme I (and II)–cytochrome *c* reductase as cytochrome b_5 bears to yeast lactic dehydrogenase (lactic-cytochrome *c* reductase) activity. It is very probable that a flavin or similar moiety mediates the reduction of the hæm of cytochrome b_5 by the substrate, as in the case of cyto-

Table 1. Comparative Properties of Microsomes from Intestinal Mucosa, Mammary Gland and Milk

Source of microsomes	DPNH–Cyt. *c* reductase activity	Cytochrome b_5 concentration	Reductase activity / Cyt. b_5 concentration
Intestine	98	3·7	26
Mammary gland	53	1·8	29
Milk	0·9	Less than 0·05	—

Reductase activities, determined as for Table 2, are expressed as μmoles of cytochrome *c* reduced/hr./mgm. total nitrogen. Cytochrome b_5 concentration is expressed as μmoles hæm/gm. total nitrogen. This was estimated by matching the *a*-band of the reduced compound with that of a standard preparation of globin hæmochromogen, using a molecular extinction coefficient of 30×10^3 for the reduced compound.

Table 2. Enzymic Activities of Microsomes from Cow Mammary Gland and Calf Intestinal Mucosa

Source of microsomes	Substrate	Acceptor	Activity: Control	Activity: With antimycin *A*	Activity: With pot. cyanide
Cow mammary gland	DPNH	oxidized cyt. *c*	26·3	23·6	—
Calf intestina mucosa	DPNH	oxidized cyt. *c*	49·2	40·0	—
	TPNH	oxidized cyt. *c*	28·7	24·2	—
	Reduced cyt. *c*	oxygen (air)	6·7	—	0
	DPNH	oxygen (air)	0·7	—	0·6

Activities, which were estimated spectrophotometrically, are expressed as μmoles substrate utilized/hour/mgm. nitrogen, assuming that 2 moles of reduced cytochrome *c* are equivalent to 1 mole of reduced diphosphopyridine nucleotide. For determining reductase activities, the final concentrations of reactants were: oxidized cytochrome *c*, 5×10^{-5} *M*; DPNH (or TPNH) approx. 3×10^{-4} *M*; potassium phosphate buffer, 5×10^{-2} *M*, *p*H 7·4; potassium cyanide, 10^{-3} *M*; and antimycin *A* (where added), 3 μgm./ml. For determining oxidase activities they were: reduced cytochrome *c*, 5×10^{-5} *M*, or DPNH, 1×10^{-4} *M*; potassium phosphate buffer, 5×10^{-2} *M*, *p*H 7·4; and potassium cyanide (where added), 10^{-3} *M*.

chrome b_3. This is seen from Fig. 1, which shows that reduced coenzyme I and sodium dithionite both cause reduction of a component absorbing in the region of 460–480 mμ in the oxidized state, presumably a flavin group. Further work is being carried out to establish whether this and the hæm group are on different proteins or attached to the one protein, as in the case of cytochrome b_3 [8].

Cytochrome b_5 of cow mammary gland and calf intestinal mucosa appears to be very similar to, if not identical with, a cytochrome in liver described by Kun[7], called cytochrome b' by Yoshikawa[9] and cytochrome m by Strittmatter and Ball[10,11], who recognized its microsomal localization. The name 'cytochrome b_5' has independently been given to this liver hæmochromogen[12] as well as to a similar pigment in the midgut of *Cecropia* larvæ[13]. The recent publication of the latter papers[11–13] has prompted us to make an early report of our independent investigations. Whether the cytochrome b_5 components of cow mammary gland, calf intestine, *Cecropia* midgut and rat liver are identical can only be established by purification studies. The microsomal-bound alkaline phosphatases of cow mammary gland and calf intestinal mucosa, for example, have similar enzymic specificity and action but are, in fact, different proteins[1,14].

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Cytochrome b_3 of Microsomes from Plant Tissues

THE microsomal fraction isolated by differential centrifuging from homogenates of white petiole of silver beet (*Beta vulgaris*) appears as a yellow-coloured pellet, as distinct from the buff-coloured mitochondrial fraction. When examined with a low-dispersion micro-spectroscope, the microsome pellet shows a broad absorption band in the blue (485–500 mμ) but no other bands in the visible region. However, after reduction with sodium dithionite, strong absorption bands appear at 560 and approximately 525 mμ, as measured with a Hartridge reversion micro-spectroscope. The α-band (560 mμ) is very sharp but shows an intensification toward the red end, suggesting an asymmetrical absorption band. The band at 485–500 mμ does not change on dithionite treatment. Microsomes isolated from onion bulb and from the spadix of *Arum* species show essentially the same absorption spectrum.

The absorption bands of the reduced compound are close to those of cytochromes b, b_2 and b_3. Moreover, the pyridine hæmochromogen of the microsomal pigment appears to be identical with that from pure protohæm, suggesting that protohæm is the prosthetic group. These facts indicate that the microsomal pigment is a cytochrome of the b group. Table 1 compares the properties of this cytochrome with those previously described for cytochrome b_3, a pigment recognized in plant tissues by Hill and Scarisbrick[1]. There is reasonable agreement in properties, and therefore the microsomal cytochrome is referred to as cytochrome b_3. While it appears that microsomal cytochrome b_3 is very similar to the cytochrome b_3 of Hill and Scarisbrick, identity can only be established by purification studies.

Table 1. PROPERTIES OF CYTOCHROME b_3

	Cytochrome b_3 of Hill and Scarisbrick (ref. 1)	Cytochrome b_3 of microsomes
Source	'Soluble' extracts of growing tips of broad bean, cotyledons of broad bean and potato tubers	Microsome fraction sedimented from homogenates of petiole of silver beet, onion apical stem and spadix of *Arum* species
Absorption bands of reduced compound	558·6 mμ to 559·7 mμ (α-band) 529·3 (β-band) (Soret band not determined)	559·5 mμ (α-band) approx. 525 mμ (β-band) 425 mμ (Soret band)
Reaction of reduced compound with air	Autoxidizable	Rapidly oxidized
Effect of carbon monoxide	Does not combine with reduced compound	Does not combine with reduced compound
Absorption bands of pyridine hæmochromogen		Broad bands at about 557 mμ (α) and 530 mμ (β)
Effect of ethanol and acetone at room temperature	Rapidly denatured	Slowly destroyed

Cytochrome b_3 of silver beet petiole and onion bulb is localized entirely in the microsome fraction. It represents about 10 per cent of the total hæm compounds of the petiole homogenate. Petiole microsomes contain about 1·5 μmoles hæm per gm. nitrogen. No detectable amount of cytochrome b_3 occurs either in the mitochondria or in the supernatant remaining after centrifuging beet or onion homogenates at 50,000 g for 1–2 hr. In contrast, Hill and Scarisbrick[1] found cytochrome b_3 in solution in extracts of leaves of broad beans and other plants. Since these workers held the tissue dispersions for about twelve hours at room temperature in order to clarify them, it is probable that the cytochrome was released from the microsomes by autolysis. Autolysis liberates other bound enzymes, such as alkaline phosphatase, for example, from microsomes of animal tissues[2]. Moreover, when a preparation from silver beet leaf and petiole was treated as described by Hill and Scarisbrick[1], the fraction obtained between 50 and 100 per cent saturation with ammonium sulphate contained both cytochromes c and b_3. Neither of these cytochromes occurs in solution in dispersions of fresh tissue.

The spectrum of the reflected light from a pellet of microsomes from silver beet petiole was kindly determined by Dr. F. Moss and Dr. R. G. Giovanelli, using a special recording spectrophotometer, and is shown as Fig. 1. When reduced with dithionite, maxima appear at 676, 560, 482, 444 and 425 mμ. It is considered that the peaks at 560 (α) and 425 mμ (γ or Soret) are those of cytochrome b_3, the β-band (at approximately 525 mμ) not being detected. The

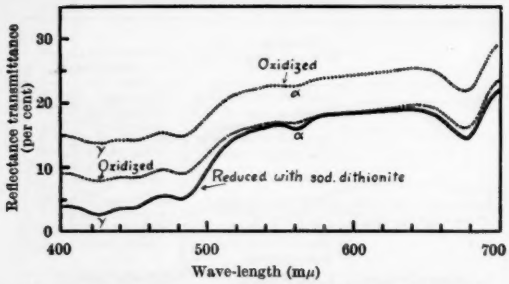

Fig. 1. Absorption spectrum of reflected light from a thick paste of microsomes from beet petiole. The preparation contained a small residual amount of cysteine (from the dispersion medium). This caused partial reduction as shown in the 'oxidized' curve. Addition of reduced coenzyme I caused no significant change in the absorption spectrum

peak at 444 mμ is possibly the Soret band of cytochrome a_3, especially since some preparations of beet microsomes in the reduced state show a very weak band at about 605 mμ (probably due to cytochromes *a* and a_3). The broad band with a peak at 482 mμ is that referred to previously as observed spectroscopically. The nature of the compound giving rise to this peak is not known. The band at 676 mμ may be due to slight contamination of the preparation with chlorophyll. Silver beet microsomes show no detectable peroxidase activity.

In view of the marked cytochrome *c* reductase activity of the plant microsomes with reduced coenzyme I (DPNH) and reduced coenzyme II (TPNH) as substrates, it seemed possible that reduced coenzyme I might reduce cytochrome b_3. Under aerobic conditions, addition of quite large amounts of reduced coenzyme I to the microsomal pellet caused no appreciable reduction of cytochrome b_3. However, when either reduced coenzyme I or II was added under strictly anaerobic conditions, there was rapid, and apparently complete, reduction of cytochrome b_3. The bands of the cytochrome disappeared immediately on exposure to air.

The very rapid rate of oxidation of reduced cytochrome b_3 by air suggests that this is unlikely to be due merely to autoxidation, but that the reaction may be enzymically catalysed by a cytochrome b_3 oxidase.

The microsomes contain no detectable amount of cytochrome *c*. However, when heart muscle cytochrome *c* is added to the microsome suspension followed by reduced coenzyme I, the bands of reduced cytochrome *c* rapidly appear. This occurs under aerobic conditions. These observations suggest that cytochrome b_3 may be related to the reduced coenzyme I and II cytochrome *c* reductase and to the reduced coenzyme I and II oxidase activities of plant microsomes.

Hill and Scarisbrick[1] observed that cytochrome b_3 of leaves was reduced in light and oxidized in the dark. Since there is accumulating evidence that coenzymes I (and II) are reduced by plant chloroplasts in the presence of light[2], this observation is consistent with the finding that reduced coenzymes I and II are substrates of cytochrome b_3. Cytochrome b_3 of plant microsomes thus appears to be the analogous hæmochromogen to cytochrome b_5 of microsomes from animal tissues[4]. Moreover, the ratio of the reduced coenzyme I cytochrome *c* reductase activity (about 26 μmoles cytochrome *c* reduced/hr./mgm. nitrogen) to the concentration of cytochrome b_3 (approximately 1·5 μmoles hæm/gm. nitrogen) is 17, and thus of a similar order to the ratio of the reductase activity to the cytochrome b_5 concentration in animal microsomes[4]. As in the case of cytochrome b_5, it seems likely that a flavin or similar moiety may mediate the reduction of the hæm group of cytochrome b_3 by reduced coenzyme I. It is hoped to establish this by purification studies, particularly as it has been found in this laboratory that yeast cytochrome b_2 is a flavohæmoprotein[5].

Antimycin *A*, a powerful inhibitor of reduced coenzyme I cytochrome *c* reductase activity in animal tissues[6], fails to inhibit this activity in microsomes from silver beet petiole, as shown in Table 2. Table 2 also indicates that the cytochrome *c* reductase activity of beet microsomes is substantially the same with either reduced coenzyme I or II.

Table 2. Reductase and Oxidase Activities of Microsomes from the Petiole of Silver Beet

Exp.	Fraction	Enzymic activity		
1	Microsomes	DPNH–cyt. *c* reductase	Control	13
			Antimycin *A*	14
	Mitochondria	DPNH–cyt. *c* reductase	Control	4·5
2	Microsomes	DPNH–cyt. *c* reductase	Control	10
		TPNH–cyt. *c* reductase	Control	13
			Antimycin *A*	14
3	Microsomes	DPNH–cyt. *c* reductase	Control	11
		DPNH–oxidase	Control	8·0
			Cyanide	8·5
		TPNH–oxidase	Control	11
			Cyanide	11

Activities, which were estimated spectrophotometrically, are expressed as μmoles substrate utilized/hr./mgm. nitrogen, assuming 2 moles of reduced cytochrome *c* are equivalent to 1 mole of reduced coenzyme I. For determining reductase activities (at 550 mμ) the final concentrations of reactants were: oxidized cytochrome *c*, 5×10^{-5} *M*; reduced coenzyme I (or II), 3×10^{-4} *M*; phosphate buffer, 0·07 *M*, pH 7·4; potassium cyanide (where added), 10^{-3} *M*; and antimycin *A* (where added), 6 μgm./ml. For determining oxidase activities (at 340 mμ) the same concentrations of reactants were used, omitting cytochrome *c*.

Microsomes from silver beet show only slight cytochrome *c* oxidase activity, and the reduced coenzyme I oxidase is not inhibited by potassium cyanide (Table 2). The microsomes thus could provide an antimycin *A*-resistant cyanide-resistant pathway for oxidation of reduced coenzyme I (and II). It is possible that this pathway may provide energy for the synthetic processes catalysed by microsomes. Certain plant tissues are known to have a cyanide-resistant 'basal' respiration, as well as a cyanide-sensitive 'salt-linked' respiration[7]. It may well be that microsomal cytochrome b_3 and the associated reduced coenzyme I oxidase system are involved in the pathway for 'basal' respiration in such tissues. The spadix of *Arum* species, in particular, has a very active cyanide-resistant respiration[8]. Preliminary examination indicates that this tissue has quite a high concentration of cytochrome b_3. Further studies on the relation of cytochrome b_3 to plant respiration are in progress.

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LETTERS TO THE EDITORS

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Genetical Effects of Radiation from Products of Nuclear Explosions

Sir John Cockcroft[1] has given a reassuring answer to the question of the genetic hazards of radiation from the products of nuclear and thermonuclear explosions disseminated to large distances. I think that he, or his biological advisers, have greatly over-estimated the simplicity of the problem. It can be attacked by several different methods. First we can fix a rough upper bound to the effect.

If an average human being has received 3 roentgens before becoming a parent, then a mean extra dose of x roentgens spread over the world's population will increase the number of mutations arising in the next generation as the results of radiation by $\frac{1}{2}x$, provided x is small.

In *Drosophila melanogaster* almost all mutations arise by a process with a temperature coefficient, and therefore presumably chemical. Isotopically labelled atoms are rarely incorporated into deoxyribonucleic acid except when it is replicated. This mutational process therefore probably occurs only or mainly during gene replication. Man has about twice as many nuclear replications per life-cycle as *Drosophila*, and a somewhat higher temperature. The chemical component in human mutation is therefore likely to be of the order of ten times that of *Drosophila* per generation. On the other hand, a human generation is about 1,000 times longer than a *Drosophila melanogaster* generation, so the component due to radiation may be expected to be about 1,000 times greater in man than in *Drosophila*. Man may have become adapted to longer generations by reducing mutation-rates; but he may also have a larger number of mutable genes. On the basis of such arguments, I suggested[2] that "it is quite possible that radiation may account for most human mutation". If so, the dose of radiation needed to double the human mutation-rates is a little more than 3 r. per generation, and not 50 r. as Cockcroft suggests. In fact, the effect of radiation is about ten times as serious as he believes.

It is also more serious for another reason. Cockcroft points out that since most British people spend most of their time indoors, the effective dose of radiation received by them is reduced to about a tenth of the outdoor dose. However, about half the human race is engaged in outdoor work, and most of the population in such countries as India live in very flimsy houses. Allowance for this fact raises the expected effect by a factor of two or three.

We do not know how much of human mortality is due to the action of natural selection in eliminating mutant genes. Haldane's[3] suggested figure of 10 per cent may be a good deal too high. But if this figure were accepted, an average dosage for the world of 0·01 r. (corresponding to Cockcroft's figure of 0·003 r. for Britain) could be responsible for about one three-thousandth of the 10^9 or so deaths which occur in a generation, say, 300,000 deaths transferred from the ages later than the mean age of parenthood to the ages before it.

This figure is probably an upper bound. We can obtain an approximate lower bound as follows. Suppose men to have no more radiosensitive genes than *Drosophila*, as against the usual estimate of five to ten times as many, then we expect one lethal and two to four sublethal mutations per 10,000 r. The latter, which cause invalidism and death after some years of life, are the more serious. If they are all fully recessive, which again is optimistic, this implies about 2 deaths per 10,000 r., or about 2,000 deaths from the 10^7 r. received by a generation of 10^9 people receiving 0·01 r. on an average.

The true number is probably somewhere between 2,000 and 300,000. I doubt whether the experiments carried out on mice up to now allow of any great precision. Those whose results have so far been published were not so designed as to allow a calculation of the rate of production of lethal mutations; and had they been so designed, the argument from mice to men is of dubious validity. It may be possible to validate this argument by experiments on human and mouse tissue cultures.

The problem is not insoluble. The figures given above could, I think, be improved. I have, however, deliberately used estimates made before the question of the genetic effects of experimental explosions was raised. Estimates made later may have been influenced by conscious or unconscious political or ethical bias. Research on this problem requires extremely careful planning, including the realization that apparently hopeful projects may prove useless.

Until the results of such research have been published, many biologists will find it hard to share Sir John Cockcroft's optimism.

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In my lecture to the Parliamentary and Scientific Committee, I said that the Oak Ridge experiments suggested a doubling dose of about 50 r. for mice, but that the extrapolation to men was obviously an uncertain one. Dr. H. J. Müller has used a figure of 80 r. with similar qualifications.

I also emphasized the uncertainty of the biological data and the need for long-term genetic studies.

Since a Committee of the Medical Research Council has been appointed to study these problems, I will not pursue the matter further.

J. D. Cockcroft

Insulin Activity of Cord Plasma

It has been shown by histological methods[1] that the islets of Langerhans form a much larger proportion of the pancreatic tissue in fœtuses and newborn infants than they do in adults, and Fisher and Scott[2] extracted relatively more insulin from the pancreas of the fœtal and newborn calf than from the same organ in later life. Hartmann and Jaudon[3] found that the injection of insulin into newborn human infants led to a moderate fall of blood sugar, and Villee[4] has stated that the fœtal tissues of man respond *in vitro*, like those of adults, to the presence

of added insulin by an increased utilization and oxidation of glucose. The newborn infant, therefore, would appear to have abundant islet tissue and to respond normally to insulin; and in keeping with all this is the well-known fact that newborn infants may have very low fasting blood-sugars[5].

Newborn rats and cats, however, and fœtal dogs, sheep and goats have been shown to exhibit relatively little fall in blood sugar and to survive doses of insulin which were many times those lethal for adults of the same species[6]. An insulin inhibitor was invoked to explain this. The difficulty of reconciling these seemingly contradictory findings led us to make a new approach and to try to obtain further evidence by an altogether different method.

We have accordingly compared directly the insulin activity of cord plasma, and maternal plasma withdrawn at the same time, by a method based upon the glucose uptake of the isolated rat diaphragm[7,8]. The procedure described by one of us (P. J. R.) was followed exactly[8]. Five mothers and infants were investigated, and they were all clinically normal; the results are given in Table 1. Maternal plasma, like the plasma of adult people not recently pregnant, exhibited highly significant insulin activity. No insulin activity could be detected in the cord plasma, and this difference between cord and maternal plasma was highly significant.

Table 1. Influence of Cord and Maternal Plasma upon the Glucose Uptake of the Isolated Rat Diaphragm

Incubation medium	No. of patients	Glucose uptake (mgm. glucose/gm. of wet diaphragm/hr.) Mean ± S.E. of mean	
Buffer	–	(*a*) 2·43 ± 0·12	(27)
Buffer + cord plasma (25 per cent plasma)	5	(*b*) 2·30 ± 0·11	(28)
Buffer + maternal plasma (25 per cent plasma)	5	(*c*) 2·99 ± 0·11	(28)

t for (*a*) v. (*b*) is 0·80, whence $P > 0·50$
t for (*a*) v. (*c*) is 3·52, whence $P < 0·001$
t for (*b*) v. (*c*) is 4·60, whence $P < 0·001$

Figures in parentheses are total number of hemidiaphragms. Samples of cord and maternal plasma taken at the same time.

It has yet to be shown unequivocally that the rat diaphragm technique detects only insulin in plasma[9]. Nevertheless, these results suggest the possibility that the cord plasma contained less insulin than the maternal plasma. If that be the case, it looks as though the islets, although numerous, are not secreting enough insulin before birth to sustain a level of plasma insulin comparable to that found in the mother.

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Deoxyribonucleic Acid Content of Nuclei in Tail Mesenchyme of *Rana pipiens* Tadpoles

Lindahl[1] has suggested the occurrence of reduction division of chromosomes in the micromeres of the 16-cell stage in the embryos of two species of sea urchins. This interpretation was based on the observation of haploid chromosome counts in anaphases and early telophases, while metaphase counts showed diploid numbers. Afterwards one of us[2] reported haploid counts from mesenchyme cells of the tail in *Rana pipiens* tadpoles. These were observed in whole mounts of stained tail tips, and occurred in stages resembling prometaphases. Other evidence, however, fails to support the suggestion of somatic reduction in the mesenchyme cells of these forms. Makino and Alfert[3] failed to find haploid numbers in micromere divisions of the sea urchin *Strongylocentrotus purpuratus*, from California; while the cytophotometric measurements of deoxyribonucleic acid in developmental stages of the sea urchin *Lytechinus* made by McMaster[4] do not reveal reduction of chromatin in the micromeres or their derivatives. In *Rana pipiens*, the cytophotometric deoxyribonucleic acid measurements of Moore[5] show the normal diploid chromatin condition in mesodermal elements.

Another possible explanation of the cytological findings of haploidy is suggested by the recent observations of Boss[6]. In cultured cells of the newt, pairing of chromosomes takes place during the anaphase movement, giving rise to apparently haploid anaphase groups.

In order to determine whether the amount of deoxyribonucleic acid per cell in the tail mesenchyme corresponds to a haploid or a diploid condition, material comparable to that examined by Green[3] has been studied by cytophotometric measurement of Feulgen-stained interphase nuclei. Material for measurement of the Feulgen reaction was prepared by the technique of freezing substitution[7]; tail tips were frozen at − 78° C. in ethyl alcohol, and substituted with the same solvent at − 30° C. After post-fixation at 60° C. in 95 per cent ethyl alcohol, the whole tips were stained with the Feulgen reaction, using 12-min. hydrolysis in *N* hydrochloric acid at 60° C. After bleaching and rinsing in water, the tips were softened in 25 per cent acetic acid, and squashed under siliconed coverslips. The coverslips were removed from the preparations by the technique of Rudkin *et al.*[8]. After clearing in xylol, the preparations were mounted in oil of closely matching refractive index (R. P. Cargille Co., N.Y.) as determined by minimal dark-field scatter.

In preparations of this type, the interphase nuclei are greatly flattened, and circular to elliptical in outline. Light absorption by the dye was measured by use of a cytophotometer similar to that described by Pollister[9]. The amount of dye per nucleus was calculated as the product of the extinction at 546 mμ and the area of the nucleus in square microns (total extinction). Absorption measurements were made of a 'plug' just smaller than the smaller whole axis of the nucleus; the area was computed from the two axes measured in the image plane. The distribution of absorbing material in preparations of this type is sufficiently uniform to ensure that errors due to this cause are small, as determined by use of a photographic scanning technique[8]. Since high extinction values were encountered, glare error was minimized by illumination of an area of minimal diameter in

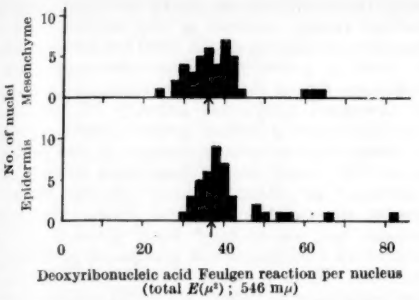

Fig. 1. Arrows indicate means at 35·74 (above) and 36·95 (below)

the plane of the object (10 per cent greater than the maximum plug size). Experiments with opaque objects of appropriate size indicated a maximum glare intensity 1 per cent of the incident intensity in the image plane.

The frequency distributions of deoxyribonucleic acid contents for groups of mesenchyme and epidermal nuclei are shown in Fig. 1. The means of the two populations do not differ significantly. Scattered values with high deoxyribonucleic acid content are considered to arise from cells in which synthesis of deoxyribonucleic acid is occurring prior to mitosis. The apparent concentration of deoxyribonucleic acid in the mesenchyme nuclei is, however, markedly higher than in the epidermal nuclei. As may be seen from Fig. 2, the relation between concentration (extinction) and area in the squashed cells falls along the calculated curve $E.A = k$, where k is the observed mean total extinction. Scattered values above the curve approach $E.A = 2k$ as a limit. Thus the difference in staining of nuclei of the two types of cell is to be accounted for purely on the basis of the dilution of a constant amount of deoxyribonucleic acid.

Cytological examination of squash preparations shows epidermal metaphase figures that are large and well spread, and that yield the diploid number of chromosomes, namely, 26. Metaphase and anaphase figures from the mesoderm are small and tend to remain clumped. No anaphase counts have been feasible. Metaphase plates which it has been possible

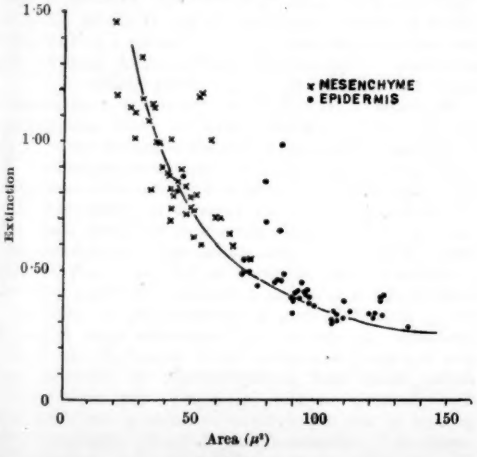

Fig. 2

to analyse show 26 chromosomes. Occasional mesodermal figures of intermediate size show a tendency to somatic pairing.

The appearance of haploidy in the 'prometaphases' in whole mounts must be regarded as a transient phenomenon, rather than as evidence of somatic reduction. Since anaphases here also show haploid counts[8], it is possible that pairing of the type observed by Boss occurs. It should be noted that instances of homologous synaptic pairing in prophase have been described by Duryee and Doherty[10] in cultured kidney and adenocarcinoma cells of *Rana pipiens*. A paired orientation of the chromosomes persisting through the interphase may account for an apparent haploidy in the prophase stages of the succeeding division.

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A Source of Ammonia and Changes of Protein Structure in the Rat Brain during Physical Exertion

WE have already shown that functional activity of the brain associated with diffuse neuromuscular activity (physical exertion by swimming) influences numerous biochemical processes in the brain. Certain metabolic processes in the brain are probably used for meeting the energy requirements of the nervous tissue during increased functional activity of the brain connected with the carrying out of physical exertion. This is shown by the fall of the actual concentration of glycogen, glucose and lactic acid in the brain[1]. Since, during increased functional activity of the brain, an increased amount of ammonia is produced, which is toxic to the nervous tissue, processes of detoxication of ammonia bound by free glutamic acid to free glutamine occur in the brain[2]. An extensive literature shows that functional activity and various modes of excitement of nervous tissue are always connected with the formation of ammonia[2]. The sources of ammonia, and the biochemical and physiological significance of the process of ammonia formation in nervous tissue during functional activity, however, have not been definitely established. The present investigation was undertaken to contribute to the clarification of this question.

Seventy-two rats weighing 150–200 gm., in six experimental series, were used. Each series contained

Table 1. Influence of Physical Exertion on Concentration of Amido-Nitrogen in the Protein Fraction of Rat Brain. (Each figure represents the average of six brains. Results are given in μmole/gm. fresh weight)

Series	Normal	After 4½ hr. swimming	Difference
1	92·4	89·0	− 3·4
2	92·7	81·7	−11·0
3	106·9	98·2	− 8·7
4	82·9	75·8	− 7·1
5	92·2	87·4	− 4·8
6	104·9	99·9	− 5·0
	95·3	88·7	− 6·6 ± 1·2

$P < 0.01$

twelve rats of approximately the same weight and age, which were divided into two groups of six animals each. One group swam for 4½ hr., under conditions previously described[1,3]. Swimming served as a model of diffuse neuromuscular activity. After cessation of swimming, the rats were thrown into liquid air and frozen *in vivo*. The frozen brains were taken out, homogenized at low temperature by crushing into fine powder and put into a weighed flask containing 100 ml. of 12 per cent trichloracetic acid. All six brains of animals from one experimental group were put in a single flask. The brains of the control animals were put in a second flask. The fresh weight of the brains was established by differential weighing.

The brain tissue was extracted twice with trichloracetic acid, then with water, and afterwards the extraction of lipids followed, which was carried out successively with 30 volumes of acetone and then alcohol–ether mixture (3 : 1 v./v.) and chloroform–methanol mixture (2 : 1 v./v.), on a water-bath under reflux. The brain tissue, freed of the acid-soluble fraction and lipids, was hydrolysed for 24 hr. with 30 vol. of 20 per cent hydrochloric acid[4]. In the hydrolysate, the total nitrogen and amido-nitrogen of the protein fraction in the brain were determined by Dawson's method[4] with small modifications. From Table 1 it can be seen that in each experimental series the concentration of amido-nitrogen in the protein fraction of rat brain is always lower in the group of rats that swam. The average decrease of amido-nitrogen is -6.6 ± 1.2 μmole/gm. ($P < 0.01$).

This decrease of amido-nitrogen in the protein fraction of the brain is specific; that is, it is not caused by general degradation of brain proteins, since we did not observe in the protein fraction of the brain any statistically significant changes of the Kjeldahl-nitrogen during the physiological process described. In accordance with this, we observed a statistically significant increase of the ratio of Kjeldahl-nitrogen to amido-nitrogen in the protein fraction of rat brain. Whereas the normal ratio of Kjeldahl-nitrogen to amido-nitrogen is 10·80 (average for thirty-six brains), this ratio has a value of 11·28 after 4½ hr. of swimming. The difference is $+0.48 \pm 0.12$ ($P < 0.02$).

These figures indicate that during physical exertion a splitting off of amido-nitrogen from the polypeptidic chain of brain proteins takes place. This amido-nitrogen originates mainly from the bound glutamine[4,5]. This bound glutamine is therefore one of the sources of ammonia in the brain. As a result of this process, the chemical and physico-chemical nature of some proteins in the brain must necessarily change, as in the polypeptic chain the bound glutamine is changed into bound glutamic acid. The electropositive amidic functional group of the protein molecule is changed into the electronegative carboxylic group.

It may be of interest to direct attention here to the marked energy content of the amidic bond in the peptides, containing about 5840 cal./mol.[6]. This amidic bond is actually a 'semi-macroergic' bond. The disintegration of this bond is apparently related to the increased functional activity of the brain nervous tissue during diffuse neuromuscular activity.

The existence of structural changes in the proteins of the nervous tissue during functional activity has been assumed by other authors[7] on the basis of changes in the sorption of vital dyes. Similarly, Koshtojanc and co-workers[8] have pointed to the significance of the functional groups of proteins of the nervous tissue; their work was, however, directed especially to functional —SH groups in the proteins of the nervous tissue. We believe we have shown the significance of the amidic group of proteins of the nervous tissue of brain for the functional activity of this tissue.

A full account of this work will be published elsewhere.

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Antibiotically Active Amino-Acid Copolymers related to Gramicidin S

The chemical structure of the antibiotic peptide gramicidin *S* has been established as cyclo-(-L-Val-L-Orn-L-Leu-D-Phe-L-Pro)$_2$ [1]. In the attempt to elucidate the relation between its chemical structure and the antibacterial activity, a number of related di-, tri-, penta- and deca-peptides have been synthesized, and their antibacterial activity tested[2]. These synthetic peptides contain some or all of the five amino-acids present in gramicidin *S* in the proper sequence. Appreciable antibacterial activity was exhibited only by the linear decapeptide.

Mixtures of N-carboxyanhydrides of α-amino-acids can be easily copolymerized to yield α-amino-acid copolymers containing a predetermined ratio of the various constituents in an undefined sequence. We were thus able to prepare polyamino-acids containing the amino-acid residues present in gramicidin *S*, as well as related copolymers, and to check their antibacterial activity. The amino-acid copolymers listed in Table 1 were obtained as follows: α-N-carboxyanhydrides of L-valine, L-leucine, L-proline, L-(D- and DL-)-phenylalanine, δ-carbobenzoxy-L-(and DL-)-ornithine, DL-alanine and sarcosine were prepared; the required monomers were mixed in the desired molar ratio and copolymerized in dioxane using diethylamine as the initiator; the carbobenzoxy groups of the copolymers containing ornithine were removed by means of anhydrous hydrogen bromide. The number average of amino-acid residues per

Table 1. ANTIBACTERIAL ACTIVITY OF AMINO-ACID COPOLYMERS RELATED TO GRAMICIDIN *S*

Copolymer No.	Molar ratio of amino-acids present in copolymer: Ala	Leu	Orn	Phe	Pro	Sarc	Val	Average number of residues per molecule	Minimal inhibitory concentration (μgm./ml.): *E. coli*	*Staph. aureus*
1	—	1 (L)	1 (L)	1 (D)	1 (L)	—	1 (L)	30	5	5
2	—	1 (L)	1 (L)	1 (L)	1 (L)	—	1 (L)	40	10–15	15
3	—	1 (L)	1 (DL)	1 (DL)	1 (L)	—	1 (L)	40	10–15	10
4	—	1 (L)	1 (L)	1 (D)	—	1	1 (L)	25	5–10	10
5	—	1 (?)	1 (DL)	1 (DL)	—	1	1 (L)	20	25–50	10
6	—	1 (L)	1 (L)	1 (D)	—	—	1 (L)	20	5	2·5–5
7	3 (DL)	1 (L)	1 (DL)	—	—	—	—	25	2·5	5–10
8	2 (DL)	2 (L)	1 (DL)	—	—	—	—	20	2·5–5	10–15
9	1 (DL)	3 (L)	1 (DL)	—	—	—	—	40	5–10	15
10	—	4 (L)	1 (DL)	—	—	—	—	25	15–25	15–25
11	4 (DL)	—	1 (DL)	—	—	—	—	20	25	10–15
12	—	2 (L)	1 (DL)	2 (L)	—	—	—	30	25–50	15–25
13	—	—	1 (DL)	—	—	4	—	30	25–50	25–50
14	1 (DL)	—	—	—	—	—	—	35	>150	>150
15	—	—	1 (DL)	—	—	—	—	18	10	5
16	—	—	—	—	1 (L)	—	—	35	>150	>150
17	—	—	—	—	—	1	—	30	>150	>150
Gramicidin *S*									5	1

polypeptide molecule was calculated from end-group analysis. The molar ratios of the amino-acids in the copolymers were determined chromatographically after acid hydrolysis. Table 1 gives the minimal concentrations of the polypeptides tested at which no apparent growth appeared within eighteen hours on incubation of an inoculum of 120,000 organisms/ml. of *E. coli* in a synthetic, or *Staph. aureus* in a semisynthetic, medium at 37°.

Table 1 shows that copolymer '1', composed of the amino-acids of gramicidin *S* in the proper ratio and steric configuration, has, under the experimental conditions used, an antibacterial activity similar to that of the natural antibiotic. The growth-curves of *E. coli* in the presence of gramicidin *S* and of the synthetic copolymer '1' at equal concentrations, given in Fig. 1, were found to be nearly identical.

A comparison of copolymers '1', '2' and '3' shows that changes in the steric configuration of the phenylalanine and ornithine caused little difference in antibacterial activity. The inactivity of polymers '14', '16' and '17' proves that the ornithine residue containing a free δ-amino group is essential for antibacterial activity. This result is in accord with the observation[3] that acetylated or deaminated gramicidin *S* is inactive. When the other amino-acids present in gramicidin *S* are omitted or exchanged by DL-alanine or sarcosine the antibacterial activity is retained to a considerable extent. In one case (No. 7) it even exceeded that of the natural product (cf. Fig. 1).

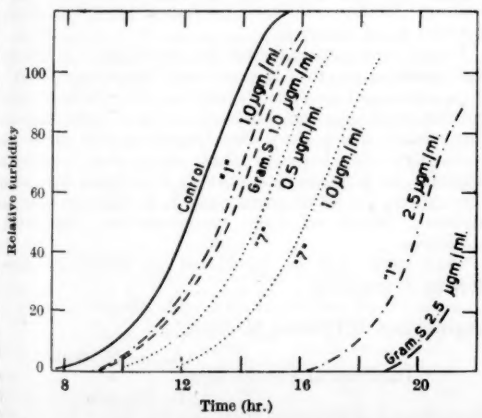

Fig. 1. Inhibition of *E. coli* (1·2 × 10⁴ organisms/ml. of synthetic medium at 37°) by gramicidin *S* (– – –), copolymer '1' (—·—·) and copolymer '7' (.....)

As all the polyamino-acids investigated have an open-chain structure, it seems that a cyclic structure is not essential for antibacterial activity in the range of molecular weights indicated in Table 1.

The mode of antibacterial action of various amino-acid copolymers in synthetic as well as in more complex media is under investigation.

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Antitubercular Effect of an Extract of *Adhatoda vasica*

THE report of Gupta and Chopra[1] on the antitubercular activity of the volatile principle of *Adhatoda vasica* prompted us to investigate the matter further.

2 lb. of undried leaf of *Adhatoda vasica* was coarsely chopped and distilled in steam to give about five litres of steam distillate. This was saturated with salt and extracted with chloroform, the extract dried over sodium sulphate and evaporated at room temperature. The brown viscid oil (3 gm.) was dried *in vacuo* below 30° C.

For the *in vitro* investigation the distillate was taken up in alcohol and serial dilutions were made in a medium of the Proskauer and Beck type. Growth of the *H37Rv* strain of *M. tuberculosis* (inoculum 0·03 mgm.) was inhibited at a dilution of 75,000 for 14 days. With a similar medium incorporating 5 per cent human serum, no inhibition was observed at a dilution of 10,000. Gupta and Chopra (*loc. cit.*)

quoted an inhibitory dilution of 500,000 for a human strain of *M. tuberculosis* (inoculum 0·01 mgm.).

The volatile principle was evaluated in 25-gm. Parkes albino mice. These were infected intravenously with the *Ravenel Rv* strain of *M. tuberculosis* (0·1 mgm.). Treatment was started on the day of infection and continued for 14 days, the drug being administered in the diet. The measured daily drug intake was approximately 340 mgm./kgm. mouse weight up to the seventh day. Median survival times of mice, with 19/20 limits of probability, were 14 (12·8–15·3) days for the treated mice compared with 16·3 (15–17·7) days for the untreated controls. This decrease in median survival time is just significant and may indicate toxicity. The pulmonary lesions, however, in the treated mice were indistinguishable from those in the controls.

It may be concluded from these results that the volatile principle of *Adhatoda vasica*, as prepared by us, has no antituberculous properties in mice on oral administration.

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Effect of Isolated Cerebral Hypoxia and Hypercapnia on Sodium Excretion

The healthy organism, as is well known, reacts to a number of influences (such as work, etc.) by decreased sodium excretion. In such cases a relative hypoxia occurs: in pathological sodium retention (cardiac decompensation, famine œdema, anæmia, etc.) an absolute hypoxia (arterial, stagnating or anæmic) can be demonstrated.

It is to be supposed that in all these states a causal relation must exist between the hypoxia and the decreased sodium excretion. We have therefore investigated, in a series of experiments on dogs, the effect of hypoxia on sodium excretion. In these experiments the rate of glomerular filtration was estimated by endogenous creatinine clearance, the sodium was determined by flame photometry, the oxygen content according to Issekutz, and the carbon dioxide according to Van Slyke.

(1) In fifteen experiments we dealt with the effect exercised on sodium excretion by hypoxia of the entire body. The dogs were under chloralose anæsthesia. The hypoxia was induced by inhalation of a nitrogen mixture containing 10 per cent oxygen. In fourteen cases the sodium excretion decreased significantly, to an average of 16 per cent. The sodium excretion occurred in some cases with unchanged sodium filtration, proving the effect to be of tubular origin.

(2) We have also investigated the question whether the fall in sodium excretion could be brought about by isolated cerebral hypoxia. For this purpose we made a preparation in which only neural connexion was maintained between the head and the body.

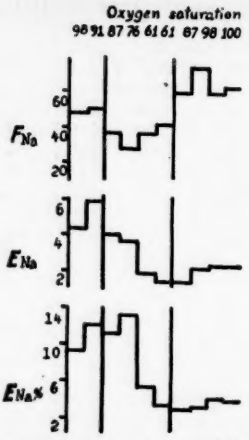

Fig. 1. *F*(Na), filtered sodium (m.equiv.); *E*(Na), excreted sodium (m.equiv.); *E*(Na%), excreted sodium as a percentage of filtered sodium

Circulation in the isolated head was maintained by a Dale–Shuster pump. In all cases the vertebral arteries and veins were ligated and in some instances the spinal veins also. In some cases the sinus caroticus was denervated. In fourteen of sixteen experiments, there was a definite decrease in sodium excretion as an effect of the cerebral hypoxia (Fig. 1). It also occurred in animals in which the spinal veins were ligated, as well as in those with denervated sinus caroticus. Hypercapnia brought about the same results.

The same effect was obtained when stagnating hypoxia was induced in the brain by reducing the perfusion pressure of the Dale–Shuster pump. In these cases, too, the sodium excretion fell to 21 per cent of the original.

Finally, during some of these experiments, we considered the effect exercised on sodium excretion by hypoxia of the isolated body. In parabiosis, the head of the acceptor animal was perfused through the carotids with blood (100 per cent oxygen saturation) from the donor dog. Hypoxia of the body of the acceptor animal was induced by inhalation of an oxygen–nitrogen gas mixture with reduced oxygen content. Sodium excretion decreased here, too, as in isolated head hypoxia.

From these experiments the conclusion is drawn that isolated cerebral hypoxia and hypercapnia lead to a decreased sodium excretion. We believe this volume-regulating phenomenon to be of importance. Our results, which show that the effect also occurs in body hypoxia, indicate that there are receptors sensitive to hypoxia not only in the brain but also throughout the whole organism. It is still a question, however, which of these receptors are the most sensitive.

This work will be published in detail in *Acta Medica Hungarica*.

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Genetic Recombination in *Streptomyces*

THE Actinomycetes have properties intermediate between those of the fungi and those of the bacteria. As in practically all bacteria and in many fungi, a sexual cycle is not known to occur in the Actinomycetes. In some bacteria and Fungi Imperfecti[1], however, there are parasexual processes[2], that is, processes leading to genetic recombination otherwise than via sexual reproduction. The present communication reports the discovery of a recombination process in an Actinomycete, *Streptomyces coelicolor* Reiner-Müller.

The two starting strains used were kindly supplied by Dr. A. Tonolo. One of them produces a deep blue pigment[3] diffusing into the agar; the other, a mutant from the first, does not produce it. Both grow well on a chemically defined minimal medium[4] containing only glucose and inorganic salts.

Two multiple mutants were isolated by successive ultra-violet irradiations of spores: one with requirements for methionine and histidine and producing blue pigment (*5 me hist*) from the first strain, and one with requirements for proline and glutamic acid and not producing the blue pigment (*14 pr glu pigm*) from the second strain. The mutants grew well either on the minimal medium supplemented with the respective requirements, or on a 'complete medium'[5] containing peptone, yeast extract, etc.

The two multiple mutant strains, *5 me hist* and *14 pr glu pigm*, were streaked separately and together on slants of agar media made up of mixtures of the minimal and the complete media (in proportions varying from 3 : 1 to 1 : 1). Separately the two strains grew very little in these mixtures; but the mixed inoculum produced abundant growth in two or three days, with intense blue pigmentation of the agar and abundant sporulation. A suspension in distilled water of spores from the mixed culture was filtered, and the spores, washed by centrifugation, were plated on the minimal medium. For 'viable counts' part of the same suspension was also plated, after suitable dilution, on the complete medium. An unexpectedly large number of the spores produced growth on the minimal medium. The time for which the mixed culture was grown before harvesting the spores and plating them on the minimal medium was varied from three to nine days with the results shown in Table 1.

As a control of the experiment reported in the first line of the table, 12×10^6 spores of strain *14 pr glu pigm* alone, plated on the minimal medium, produced no growth; neither did $24{\cdot}7 \times 10^6$ spores of strain *5 me hist* alone. Even a mixed suspension of spores of the two strains (34×10^6 spores) obtained from separate cultures produced no growth. Clearly a period of mixed growth is necessary for spores producing prototrophic colonies to arise.

Table 1

Mixed culture medium (min./ complete)	Age of mixed culture (days)	No. of spores from mixed culture plated on the min. medium (corrected for viable counts)	Colonies growing on the min. medium ('prototrophic')	Prototrophic colonies per cent of spores plated
1/1	4	46×10^6	10,800	0·023
3/1	3	$3{\cdot}4 \times 10^6$	260	0·008
3/1	4	4×10^6	0	0
3/1	6	580	250	43
3/1	7	7,000	910	13
3/1	9	4,000	780	19

Table 2

Mixed culture medium (min./ complete)	Age of mixed culture (days)	Supplements added to the min. medium for plating spores from mixed culture	Rate of recombination (per cent)	No. of colonies tested	Recombinant types obtained No.	Type
1/2·3	7	proline, histidine	3·1	36	3	*pr*
					4	*hist*
					29	+
1/2·3	7	glutamic, methionine	1·4	482	1	*me*
					481	+
1/1	16	histidine, glutamic	19	168	9	*hist*
					7	*pigm*
					136	+
1/1	16	methionine, proline	4·6	300	34	*pr*
					2	*pr me*
					264	+

The symbols indicate the requirement or the absence of blue pigment (*pigm*). + indicates the wild type, that is, no requirement and presence of blue pigment.

Recombinant strains presenting requirements of one or both of the parent strains were identified and selected by the following method. Spores from mixed cultures were plated on the minimal medium partially supplemented with the substances required by the parent strains. All the possible combinations of substances required by the parent strains were tried except those which would permit the growth of either or both parent strains.

A number of colonies showing growth on these media were tested for their nutritional requirements, and the presence or absence of the blue pigment noted. Table 2 gives details of the results.

Thus, three types of recombinants occurred among the strains isolated: (*a*) with all the 'wild' characters of the starting strains; (*b*) with some 'wild' characters of one strain and some mutant characters of the other strain; (*c*) with mutant characters from both strains (*pr me*).

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Rate of Metabolism in Tardigrades during Active Life and Anabiosis

SOME species of tardigrades are noted for the ability to survive complete desiccation[1]. When dried, the animals are able to withstand extreme temperatures and lack of oxygen. The experiments described here were made with the purpose of contributing to the knowledge of the metabolism of tardigrades during the period of anabiosis.

First, the rate of metabolism during anabiosis was measured and compared with that during active life[2]. Two species were used: *Macrobiotus hufelandi* Schultze, a moss-inhabiting species, able to survive

Table 1. Oxygen Consumption at 20° C.

Species and life-stage	Oxygen (μl. × 10^{-4}) per hr. per individual
M. dispar	
Active	1,000
Cyst	240
M. hufelandi	
Active	980
Dried	1·6

lack of water, and *Macrobiotus dispar* Murr., a fresh-water form, able to encyst. The oxygen consumption was measured at 20° C. by the Cartesian diver micro-gasometer, as developed in the Carlsberg Laboratory, Copenhagen, except with dried animals, when a minor modification was introduced to increase sensitivity[2]. The results are summarized in Table 1; they show clearly the difference between encystment metabolism and true anabiosis.

In the second series of experiments the relation between rate of metabolism of dried *M. hufelandi* and humidity of the air was investigated[4]. Both the 'standard' and the 'sensitive' type of the Cartesian diver were used. The humidity of the air was kept constant by placing in the divers droplets of sodium chloride or calcium chloride solutions of appropriate concentration. The divers were charged with 300 or 30 animals, according to the rate of metabolism. The results are shown in Table 2.

Table 2. Oxygen Consumption by Dried *M. hufelandi* with Different Relative Humidities of the Air, at 25° C.

Relative humidity (per cent)	Oxygen (μl. × 10^{-4}) per hr. per individual
25	0·4
48	0·4
59	1·1
75	2·4
83	2·9
90	4·8
93	7·6
95	27
96	57
97	89
98	160
99	340
100	690
Water	1,130

The results show a logarithmic increase of metabolic rate with increase in humidity of the atmosphere. At the lowest humidities (25 and 48 per cent) the respiratory rate is very slow, and the error involved accordingly large; the results show merely that there is some oxygen consumption at these humidities. Respiration in water recorded in Table 2 differs slightly from the results in Table 1; it was measured with the same animals which were used in the investigation of the effect of humidity on respiratory rate.

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Location of Enzymes in Mitochondria Fractions

It appears from several published works during recent years that a large number of enzymes have been located in the mitochondria fractions by means of differential centrifugation of tissue homogenates, especially of animal cells. Duve and Berthet[1] have tried to standardize the conditions of centrifugation in different types of instruments so that the results may be reproduced, and they urge that some attention should be paid to such factors as diffusion- and convection-currents and also to the manner of decantation. Some errors are, however, possible with this type of work, as have been pointed out by Brachet[2] while discussing the nuclear control of enzymic activities; during homogenization and differential centrifugation soluble enzymes can no doubt be adsorbed on particles; but the microsomes (submicroscopic cytoplasmic granules) may release enzymes which are normally bound to them just as in the case of crushing the cell constituents in different media. By this method it is scarcely possible to get information on the interactions occurring between the different fractions in a normal living cell and to be sure that the various particles obtained by differential centrifugation are really the ones which pre-existed in the intact cell. In this connexion, Holter[3] has also discussed the profound changes that the process of homogenization involves; he points out that the hyaline ground plasm of most cells is not miscible with water and that a certain degree of autolysis is indispensable in order to set the cytoplasmic particles free and that this autolysis must have far-reaching consequences with regard to enzyme yield and enzyme distribution.

By growing fungi (*Polyporus durus*, *Polystictus sanguineus*, *Daedalea flavida*, *Phoma casuarinae*, etc.) separately in fatty acid medium, 4 per cent glucose and 2 per cent peptone medium, I[4] obtained synthesis of fat drops, glycogen granules and protein granules respectively around the vacuoles in growing hyphal tips. My attention[5] was first directed to this kind of work following the deposit of starch grains in various algae (*Spirogyra*, etc.) around the pyrenoids which show vacuoles at their centre. By following the successive stages of plasmolysis of a healthy fungal cell one can observe how the vacuolar membranes act as seats of hydrolysis as well. From the experimental facts I formed the conclusion that the plant vacuoles (especially in fungi) most probably function as store-houses of enzymes. The late Prof. Guillermond[6] discarded the idea that the mitochondria are the means by which every synthesis in plant cells takes place. To get satisfactory evidence, "the mitochondria must be broken down into less organized units and finally the enzymes should be isolated and characterized" (cf. Davies[7]).

It should be noted, however, that young healthy green plant cells in the growing state always contain a number of vacuoles and two types of mitochondria (cf. Sorokin[8])—'active' mitochondria which become transformed into plastids and which do not colour with vital stain (Hoechst's Janus green *B*), and 'inactive' ones which remain as such and specifically colour blue with Janus green *B*—but in the majority of fungi 'active' mitochondria (that is, plasts and plastids) are lacking.

According to Cowdry[9], normal healthy animal cells, which are devoid of plastids, contain very few or no vacuoles, and since highly vacuolated cells die off more rapidly than the non-vacuolated ones, the

vacuoles have been called by Cowdry degeneration-vacuoles. Hence, it may be possible that in animal cells mitochondria are structurally associated with enzymes within the living cell; but recent studies of Duve *et al.*[10] on rat liver cells show that this conclusion is not necessarily warranted.

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Plane of Bilateral Symmetry in Plant Cilia

The fact of bilateral symmetry in cilia has been much more easily demonstrated than the plane of symmetry itself. The fact is implicit in the numerical relations of the component fibrils[1] (a ring of nine around a central pair); but unless there are external appendages or some other criteria with respect to which the orientation of the whole organ can be interpreted the median fibril cannot be recognized. This difficulty was encountered by Fawcett and Porter[2], who interpreted their very fine sections of animal cilia in terms of a plane of symmetry passing through and not between the two central strands, and a similar interpretation was given by Manton, Clarke and Greenwood[3] for the seaweed *Dictyota* on the basis of external morphology. In neither case, however, was the possibility excluded that the plane of symmetry might in fact be at right angles to the line joining the two central strands, and Fawcett and Porter's outline diagrams do indeed somewhat suggest this.

In the attempt to obtain direct and conclusive evidence on the internal orientation, sections have been cut of the cilia of a number of plant genera with apparently suitable morphology. Several have since been discarded as unsuitable for different reasons; but success has been achieved with the spermatozoids of the brown seaweed *Fucus*. For this[4] it is already known that the front flagellum has two rows of lateral hairs and that there is a peculiar and highly characteristic membranous organ (the 'proboscis') at the base. The smooth hind flagellum, which is without appendages, is held in a fixed position where it passes over the eyespot. Sections through either of these two special regions would give the desired information.

Sections of these and other levels will be published in detail elsewhere; but one sample is reproduced in Fig. 1. It is part of the front end of a longitudinally cut spermatozoid in the region of the upturned proboscis and front flagellum, both of which are cut approximately transversely. The mutual relations of the flagellum and proboscis make it quite certain that they belong together and that the section is not far above their point of union. The plane of section is such that the hairy appendages (Flimmer) are visible on both sides of the flagellum. Since there is no precise correspondence between the levels at which the hairs emerge on the two sides the slight obliquity of the section is a prerequisite to locating both lateral lines simultaneously. The interpretation of the section is further assisted by the fact that dismemberment of the cilium has begun to take place, the ciliary membrane being partially disrupted and the fibrils, except for two on the left-hand side, being spaced farther apart than would otherwise be the case.

The critical details are shown in an outline diagram beside the photograph. As in *Dictyota*, it is found that the odd (median) fibril lies outwards with respect to the cell body. If this fibril is numbered 0 and the others 1, 2, 3, 4, on each side, the origin of the lateral hairs is in close proximity to fibril 2, again as in *Dictyota*. It is quite obvious, however, that the plane of bilateral symmetry of the outer ring (marked by the arrow in the diagram) passes between but not through the two central strands. The line joining these strands is therefore in, or parallel to, the plane of dorsiventrality of the whole organ but at right angles to the plane of bilateral symmetry.

With this information it is possible to interpret sections of the smooth hind flagellum where it passes over the eyespot, and it is found that, as in the front flagellum, the plane of dorsiventrality is parallel to the body, and the odd median fibril of the peripheral ring is outwards.

It is thus fully apparent that, even when there is no visible structural differentiation among the nine members of the peripheral ring, the orientation of the whole organ is by no means at random. This was already indicated from Fawcett and Porter's sections and their observation that, when cilia are arranged in rows as in the gill epithelium of *Mya*, the central pair of fibrils in every cilium is in a plane at right-angles to the row. It may now be suggested that this plane is likely to be that of dorsiventrality, the plane of symmetry in *Mya*, as is *Fucus*, being at right-angles to this and therefore parallel to the direction of the row.

All this supports strongly the view put forward on previous occasions by us and no doubt by other workers that bilateral symmetry in cilia is likely to be of primary functional significance for the mechanism of their movements.

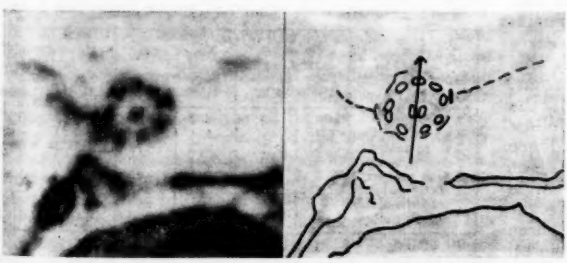

Fig. 1. Electron micrograph (*M*213.13) of a section cut near the base of the front flagellum of the spermatozoid of *Fucus serratus*; part of the cell body and membranous proboscis visible below the flagellum. For further explanation, see line diagram and text. Magnification × 30,000

The micrograph reproduced was taken on the Philips' electron microscope in the research laboratories of Tootal Broadhurst

Lee Co., Ltd., of Manchester, whom I have to thank for giving me hospitality at a time when our own instrument was too heavily loaded with other work to be available. I have specially to thank Dr. P. Chippindale for making this arrangement possible.

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Behaviour Differences in Two Strains of *Aëdes aegypti*

Attention has recently been directed to differences in the hatching response between eggs of a West African strain of the mosquito *Aëdes* (*Stegomyia*) *aegypti* (L.) from Lagos, Nigeria, and those of an East African strain of the same species from Newala, Tanganyika[1]. Further work on these two strains now discloses differences affecting behaviour of the adults: in the Lagos strain, unmated females usually lay eggs within five days of taking a blood meal; in the Newala strain, unmated females rarely lay eggs within this period (Table 1).

Table 1. Proportion of *A. aegypti* laying Eggs within Five Days of taking a Blood Meal

Lagos strain		Newala strain	
Mated	Unmated	Mated	Unmated
61/67 (91 per cent)	74/86 (86 per cent)	48/54 (89 per cent)	4/53 (8 per cent)

The relation between mating and ovulation has been noted by various workers in certain Anthomyid and Tachinid flies[2–7] and in *A. aegypti* by MacGregor[8], who claimed that ovulation was dependent on the presence of sperm in the spermathecæ and of blood in the stomach. Whatever the male's contribution is, in this species, it is clear that in the Lagos strain the female is largely or wholly independent of it. The following preliminary experiments provide some additional information on this subject.

When unmated females of the Newala strain were afterwards mated at varying intervals from 3 to 23 days after a blood meal, 61 out of 76 (80 per cent) of them laid their eggs on the second or third day after fecundation. Thus, while blood in the stomach is necessary for activation of the ovaries, it is clearly not necessary for ovulation, which appears in this strain to depend on mating only. It is apparent, however, that the act of mating is itself not the effective stimulus, since ovulation did not follow when females were mated to infertile males. Evidence for this was obtained by mating groups of eight females, one at a time in quick succession, to single males. Each male was able to cope with the eight females one after another; but only the first three or four females were successfully fertilized (Table 2). Repeated feeding of these groups of females at 6-day intervals did not alter the overall picture; after each feed, fertile eggs were laid by the first three or four mates, a few infertile eggs were laid by some of the fourth and fifth mates, but no eggs were laid by any of the sixth, seventh or eighth mates.

Table 2. Combined Results of mating 5 Groups of 8 Females each (*A. aegypti* Newala Strain) to Single Males (see Text)

♀♀ (8/♂) in order of mating	No. of ♀♀ laying eggs		No. of eggs laid		Mean day of laying	
	Fertile	Infertile	Fertile	Infertile	Fertile	Infertile
5 first mates	5	—	399	—	2·0	
5 second mates	5	—	335	—	2·4	
5 third mates	5	—	325	—	2·4	
5 fourth mates	2	1	177	17	3·0	3·0
5 fifth mates	—	1	—	3	—	5·0
5 sixth mates	—	—	—	—	—	—
5 seventh mates	—	—	—	—	—	—
5 eighth mates	—	—	—	—	—	—
Totals	17	2	1,236	20		

While these results seem to support the first part of MacGregor's claim, that it is the presence of sperm in the spermathecæ which stimulates ovulation, the following observations suggest that it may in fact be the presence of seminal fluid rather than sperm. Males of the Newala strain, apparently exhausted of sperm by three or four consecutive matings, were again able to fertilize females after a rest of 36 hr. When, however, apparently exhausted males were rested for shorter periods, mating resulted in the laying of infertile eggs. Thus even sixth and seventh mates were induced to lay batches of 84 and 87 infertile eggs on days 3 and 4 respectively. It seems possible that females of the Newala strain ovulate when they receive spermless seminal fluid, and this may perhaps account for small numbers of infertile eggs laid by some of the fourth and fifth mates, that is, when sperm is exhausted but fluid is nevertheless introduced into the spermathecæ.

When these experiments were repeated using the Lagos strain, the results were entirely different. Females mated to infertile males resembled normally mated females in usually laying their eggs within two to five days of taking a blood meal (Table 3). The number of infertile eggs, however, laid by such females was usually less than the number of fertile eggs laid by normally mated females, and they were usually laid some 12 hr. later. Unmated females of the Lagos strain, or females mated to infertile males, continued to lay batches of infertile eggs within two to five days after each of ten successive blood meals.

It is suggested that females of the Lagos strain produce some substance which stimulates ovulation, and that extra production of this substance follows impregnation by the male. This substance seems to

Table 3. Combined Results of mating 7 Groups of 8 Females each (*A. aegypti* Lagos Strain) to Single Males (see Text)

♀♀ (8/♂) in order of mating	No. of ♀♀ laying eggs		No. of eggs laid		Mean day of laying	
	Fertile	Infertile	Fertile	Infertile	Fertile	Infertile
7 first mates	6	1	404	52	2·5	4·0
7 second mates	7	—	454	—	2·9	—
7 third mates	5	2	323	79	2·6	3·0
7 fourth mates	6	1	304	80	2·7	3·0
7 fifth mates	5	2	245	49	3·4	3·5
7 sixth mates	2	5	51	248	3·0	3·2
7 seventh mates	—	7	—	298	—	3·6
7 eighth mates	—	7	—	280	—	3·7
Totals	31	25	1,781	1,086		

Average No. of eggs/fertile female = 57·5
Average No. of eggs/infertile female = 43·4
Mean laying time of fertile eggs = 2·9 days
Mean laying time of infertile eggs = 3·4 days

be wanting in females of the Newala strain, but appears about two days after impregnation by the male. Such a substance might be a product of the corpus allatum or of the neurosecretory cells in the brain[9], production of the substance depending, in the Newala strain, on a stimulus resulting from filling of the spermathecæ.

A series of crosses between these two strains is now being undertaken, in the hope that further light will be thrown on this subject.

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Cell Surface and Fertility in *Escherichia coli*

FERTILE or F^+ strains of *Escherichia coli* have been defined[1,2] as those which are productive of recombinants even when crossed with sterile strains; other strains, F^-, are defined as those which are productive of recombinants only if crossed with fertile strains. Fertility is transmissible from F^+ to F^- cells by 'infection' due to an agent (F) which is not separable from the cells[1,2].

The screening of strains and clones for fertility depends upon these definitions, namely: (1) capacity to recombine with test strains of known F polarity; (2) ability to transmit fertility to sterile strains. Such methods, even in the most skilful hands, are time consuming and discourage the undertaking of large-scale experiments. Unfortunately, no changes, either morphological or physiological, have been correlated so far with the F^+ state, other than the strictly genetical ones already mentioned[2].

Nevertheless, it seemed worth while to investigate the surface of cells endowed with opposite F polarity. Such investigations, which are in progress in this Institute, on different lines of work, have already yielded some consistent results which are here presented.

Eight strains of *E. coli K* 12 (kindly supplied by Dr. L. L. Cavalli) were chosen which allow of factorialization of: (1) two groups of markers, including biochemical deficiencies, sugar fermentation and virus resistance; (2) sensitivity and resistance to an antibiotic (streptomycin); (3) fertility and sterility. Cells of such strains, from standardized cultures, were washed twice in distilled water and were suspended in a buffer (citric acid/disodium hydrogen phosphate) adjusted for pH values ranging from pH 2 to 5, at intervals of pH 0·2, in order to determine for each strain at which pH suspended cells are precipitated. The results and their analysis show that the factor which has by far the most effect on the pH-precipitability of the strains studied is the F polarity, the precipitating pH for F^- strains being highly significantly more acidic than that for F^+ strains. In addition, analysis of the results shows that a minor but significant effect is due to the markers already mentioned.

Secondly, on staining the same strains at different pH values, by means of a mixture of an acid and a basic dye, like methylene blue and acid fuchsin[3], F^- strains show a greater affinity for the basic dye than F^+ strains.

Thirdly, the nephelometric study of the growth pattern in liquid medium (*I.S.M.* nutrient broth, pH 7·3) shows that there is a greater spontaneous instability of broth-cultures of fertile strains, compared with that of the corresponding sterile strains. In fact, both F^- and F^+ strains grow at the same rate for the first few hours, up to a population density at which F^+ cells are spontaneously precipitated, but F^- cells do not. In other words, the greatest density of growing cells which can remain stably suspended in the culture medium is far greater for sterile strains than for fertile ones.

As a whole, these results suggest a difference in surface charge between the strains studied, due to a difference in F polarity. This conclusion is supported by an electron microscopic investigation on the same strains, which showed no morphological equivalent of fertility at the level of the cell surface. Indeed, presence or absence of an outer membrane, of cilia, filaments[4], etc., seems to be unrelated to F polarity. But a not irrelevant by-product of this investigation is the demonstration that, while all the eight strains are ciliated, only the four bearing markers for deficiency for biotin and methionine and resistance to phage T_1 are endowed with filaments, while the four strains bearing the other group of markers, namely, deficiency for threonine, leucine and thiamine, inability to ferment lactose, galactose, maltose, arabinose, xylose and mannitol, are completely devoid of filaments. This conclusion has promoted other investigations using such a 'morphological marker' to study the phenology of the F transmission and to detect the biochemical pattern correlated with production of filaments by the bacterial cell.

Determination of the ζ potential on cells with opposite F polarity will be the logical development of experiments quoted above; but results on electrokinetic mobility can be very misleading, unless they are based on a substantial knowledge of the morphology of the cell surface[5]. This is one reason why an electron microscopic investigation was carried out at this point in our researches. On the other hand, it seems that the finding of a chemico-physical property and a cultural pattern associated with fertility, at least so far as the eight strains studied are concerned, supplies a simple and, therefore, useful technique for studies on the transmission of the F^+ state. In fact, recombination tests applied to forty clones from each of two F^- strains, infected with two different F^+ strains, have yielded results fully consistent with a previous screening of the same clones for growth pattern in *I.S.M.* nutrient broth.

Further, the description of the eight original strains, by means of the nephelometry of forty clones of each, has given quantitative results very suitable for thorough statistical analysis, which has supplied information in perfect agreement with that given by the pH-precipitability experiments.

What is more important, the same technique permits a detailed study of the kinetics of infection and has already produced results completely confirming and integrating what is known on the transmission of the F agent. Further investigations are being carried out.

Fertility and sterility in bacterial cells may thus be nothing more than an epiphenomenon of their surface charges; on the other hand, the observed differences of surface charge may be a minor effect of the *F* agent which is supposed to transmit fertility. Our results make the first hypothesis no more unreasonable than the second one.

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Herpetichthyes, Amphibioidei, Choanichthyes or Sarcopterygii?

During recent decades, our ideas on the classification of fishes have changed greatly. In the early years of the century, it was believed that among the higher bony fishes (Osteichthyes) the ray-finned forms and crossopterygians were closely allied, and that the lungfishes were remote from the two, representing a presumably primitive if aberrant group. As an expression of such beliefs may be cited Goodrich's work on fishes in the Lankester "Treatise on Zoology"[1], in which the Osteichthyes are divided into two subclasses, one for the Dipnoi alone, the other, the Teleostomi, including both Crossopterygii and the Actinopterygii. In succeeding decades, however, a radical change of opinion occurred. Principally due to the work of Goodrich himself and of Gregory and Watson, it became clear that the primary dichotomy of the Osteichthyes was of another sort, one major subdivision including the Actinopterygii alone, the other both Crossopterygii and Dipnoi. Huxley, in 1880[2], coined the name Herpetichthyes to describe the sub-tetrapod evolutionary stage represented by *Ceratodus*, and Smith Woodward, in 1931[3], suggested the expansion of the term to include (*contra* Huxley) the crossopterygians. Hubbs, in 1919[4], proposed Amphibioidei for Dipnoi plus Crossopterygii, and other writers have suggested an expansion of Crossopterygii to include the Dipnoi as well. Säve-Söderbergh, in 1934[5], in an unorthodox essay in classification, proposed a major subdivision of the vertebrates, including all the tetrapod classes plus the two fish groups concerned, to be named the Choanata, in reference to the presence of internal nostrils. I have (like others) rejected this classification, but in 1937[6] suggested that Choanichthyes would be appropriate as a designation for the included fish groups. None of the three terms previously suggested has met with any marked degree of acceptance; Choanichthyes has been adopted by a number of recent writers.

The deadening hand of legal 'priority' fortunately does not (and should not) extend to systematic categories on this high level. Names of this sort should be meaningful and, if possible, diagnostic—particularly in such a group as that under consideration, which is of such importance that it merits mention and discussion on even the most elementary levels of zoological and geological teaching. From this point of view, I feel dubious as to whether the term Choanichthyes should be retained. The lungfishes have internal narial openings, to be sure, and it seems certain that the crossopterygian ancestors of the tetrapods had choanæ. But in coelacanths, choanæ were lost at a very early stage, if ever present at all. The internal narial openings of the lungfish do not function as choanæ, for they are passages for water, not air, and Jarvik[7], among others, has raised doubts as to their homology with true choanæ.

But despite my doubts about the use of the term Choanichthyes, no better case can be made for alternatives which have been proposed. As regards the use of Herpetichthyes or Amphibioidei, the fishes concerned are related to amphibian ancestry; but the only living member of the group, *Latimeria*, is as un-amphibian as any fish can be. To use Crossopterygii in the expanded sense proposed would distort the meaning of the term so greatly as to create confusion.

A name which is highly appropriate and didactically useful can, however, be derived from fin structure. In contrast to the typical Actinopterygii, all crossopterygians and lungfishes have fleshy, lobate fins, covered with scales and with a well-developed internal skeleton of archipterygial type. May I suggest, for discussion, the possibility that, in contrast to the 'ray-finned fishes', the forms here considered be termed 'fleshy-finned fishes'—Sarcopterygii?

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We are glad to see Prof. A. S. Romer's authority withdrawn from the unhappy term Choanichthyes; but we do not think it necessary or desirable to coin a new one to cover the Rhipidistia, Actinistia and Dipnoi. We would revert to calling them all Crossopterygii.

The name Crossopterygii in its original form (Crossopterygidae) was introduced by T. H. Huxley[1] to include members of all of the above-named groups, as well as *Polypterus*, which to-day is excluded from the Crossopterygii in whatever sense the term is used. In Huxley's Crossopterygidae were *Osteolepis*, the Coelacanthidae, *Dipterus*, *Phaneropleuron* and the fossil *Ceratodus* (the last with a query, since it was known only from dental plates). Huxley further directed attention, "without wishing to lay too much stress upon the fact", to the resemblance between *Lepidosiren*, the only living dipnoan then known, and *Dipterus*, *Phaneropleuron* and the coelacanths, mentioning the paired fins and the endoskeleton and comparing the teeth with those of *Dipterus* and the "stiff-walled lung" with the ossified air bladder of one of the fossil coelacanths.

In 1881, in the work referred to by Prof. Romer, Huxley was thinking as a comparative anatomist, and gave the name Herpetichthyes to *Ceratodus* (= *Neoceratodus*) and its hypothetical ancestors.

Ceratodus was, he wrote, "an extraordinarily little-modified representative of that particular stage of evolution of which both the typical fishes and the Amphibia are special modifications". He did not correlate this conception with his earlier study as a palæontologist, and his term does not suit our present purpose.

We now know of the close relationship between *Neoceratodus* and the fossil Dipnoi among Huxley's Crossopterygidae. The classifications which set the Dipnoi apart from the Rhipidistia were first those such as Goodrich's of 1909[2] and Berg's of 1940[3], which grouped the Rhipidistia and Actinistia with the Actinopterygii as Teleostomi. In so doing, Goodrich did away with the term Crossopterygii; but in 1930[4] he revived it for Rhipidistia and Actinistia, though still as a division of Teleostomi.

Some authors (Stensiö[5], Romer[6,7]) who have not admitted the major cleft between Dipnoi and Teleostomi have still used Crossopterygii for the Rhipidistia and Actinistia only; hence their need for another name under which to unite them with the Dipnoi. Others (Regan, 1929[8]; Moy-Thomas, 1939[9]; Trewavas and White, 1950[10]) have used Crossopterygii again in Huxley's sense, purged only of *Polypterus*. This latter course we believe to be the most useful.

Westoll[11], in a closely reasoned comparison of Dipnoi and Rhipidistia, concludes (p. 159): "The evidence of Devonian forms shows very clearly that the early Dipnoi were very closely related to the contemporaneous Rhipidistia". It is generally accepted that the Actinistia (Coelacanthini) were an early offshoot from the Rhipidistia, and such adumbrations of the soft anatomy of *Latimeria* as we have so far received[12] show that the two "living fossils", *Latimeria* and *Neoceratodus*, have retained many features of a common archaic organization.

These facts all support the classification of Regan and Moy-Thomas, that is:

Crossopterygii

Rhipidistia (Osteolepidoti).
Actinistia (Coelacanthini).
Dipneusti (Dipnoi).

There is much, however, to be said for indicating the closer relationship of Osteolepidoti and Coelacanthini to each other than to the Dipnoi[13,14]. This could well be done in the following classification, which we now propose:

Subclass Crossopterygii

Order Rhipidistia.
Suborder Osteolepidoti.
Suborder Coelacanthini.
Order Dipnoi.

The meaning of Rhipidistia ('fan-sails') is appropriate to both its suborders. The term Actinistia is well lost in favour of its familiar synonym Coelacanthini. Those who have used the text-books of Stensiö, Romer[7] or Forster-Cooper[15] have no new terms to learn, but need only note that Crossopterygii is used in its old, wider sense and Rhipidistia in a newly expanded sense. The roots of the subordinal names could be used, if desired, with endings uniform with those of any system (Osteolepidoidea, Coelacanthoidea for Regan's classification).

To conclude, we advocate reversion to the use of Crossopterygii in the sense of Regan and Moy-Thomas as a subclass of the class Osteichthyes (= Pisces *sensu* Regan), to include the Rhipidistia (= Osteolepidoti + Coelacanthini) and Dipnoi. In support of this we plead: (i) continuous though not universal usage, only slightly modified from that of its original proposer, (ii) a suffix which corresponds to that of the equal-ranking Actinopterygii, and not to the words Dipnoi or Dipneusti, (iii) an appropriate meaning, (iv) conformity of the resulting classification with the results of recent research and (v) the possibility it provides of discarding redundant terms rather than coining new ones.

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In vitro Stimulation of Incorporation of Formate-^{14}C in Surviving Uterine Segments by Hydroxylated Œstradiols

Recent studies in this laboratory have demonstrated that the incorporation of formate-^{14}C into protein by surviving uterine segments is an early and sensitive indicator of œstrogen action (unpublished work with A. M. Herranen). Six hours after a single intravenous injection of 10 μgm. of œstradiol-17-β, the incorporation of formate *in vitro* by uterine horn segments is accelerated 250 per cent over the controls. The addition of the natural hormones directly to the *in vitro* incubation media has little or no effect on formate metabolism. In contrast, it is shown in this communication that the addition of the 2-hydroxy or 4-hydroxy derivatives of œstradiol to the reaction mixture results in a significant acceleration of the incorporation of formate-^{14}C into the proteins of the uterine segments.

The 2-hydroxy and 4-hydroxy derivatives of œstradiol (2,3,17β-trihydroxy œstratriene and 3,4,17β-trihydroxy œstratriene) were synthesized by a route involving the nitration of œstrone, chromatographic separation of the positional isomers, reduction of the 17-keto group, reduction of the nitro group and the photodecomposition of the diazonium salts. In addition, the 4-hydroxy œstradiol was synthesized by an alternative route through the 4-phenyl azo compound. Details of synthesis and proof of structure will appear elsewhere (unpublished work with M. E. Mills).

Assay of these compounds for their ability to induce uterine growth in 21-day old mice demonstrated that the 4-hydroxy œstradiol derivative

possessed 10 per cent of the œstrogenic potency of œstradiol-17β, whereas the 2-hydroxy œstradiol retained less than 1 per cent of the activity of the unsubstituted œstrogen. Similar results were obtained in ovariectomized adult female rats.

For the *in vitro* tests, uterine horns were removed from adult female rats (Holtzman strain) which had been ovariectomized two months prior to the experiments. After immediate cooling of the tissue in iced Robinson media[1], each horn was opened lengthwise and cut into four equal segments. Twelve segments were selected at random and transferred to iced reaction flasks containing 2 ml. of media. The latter was composed of 0·005 *M* sodium formate-^{14}C ($0{\cdot}55 \times 10^8$ counts/min. per μmole), 0·005 *M* glycine and 0·022 *M* glucose dissolved in Robinson media. Where indicated, 10 μgm. of a natural œstrogen or a hydroxylated derivative was added to the flask in an ethanol solution and the ethanol evaporated prior to the addition of the reaction mixture. All experiments were conducted in duplicate.

The incubations were carried out in an atmosphere of 100 per cent oxygen at 37·5° C. with constant shaking for a period of 3 hr. The reaction was terminated by the addition of perchloric acid to yield a concentration of 4 per cent. The uterine segments were removed, frozen in liquid air, and pulverized in a stainless steel mortar. This residue was suspended three times in 5 ml. of 10 per cent trichloracetic acid to remove acid-soluble radioactive contaminants. Lipoidal materials were removed by suspension in 70 per cent ethanol, followed by two hot extractions with absolute alcohol (20 min. at 70–75°) and two washes with ether. The nucleic acids were extracted from the protein with 4 per cent perchloric acid at 90° according to the method of LePage[2]. After washing successively with cold perchloric acid, ethanol and ether, the protein residue was spread on tared aluminium disks for counting. The dried samples were counted in gas-flow proportional counters. The results are expressed as counts per minute per milligram of protein residue corrected for self-absorption and counting efficiency.

A comparison of the effects of 2-hydroxy and 4-hydroxy œstradiols with the natural œstrogens, œstradiol, œstrone and œstriol, is illustrated in Table 1. It is apparent that both ring *A* hydroxylated œstradiols stimulate the incorporation of radioactive formate, while the natural œstrogens are essentially inactive.

Table 1

Addition	Counts/min./mgm. protein
None	224
Œstradiol-17β	241
Œstriol	222
Œstrone	200
2-Hydroxy œstradiol	365
4-Hydroxy œstradiol	356

10 μgm. of a hormone was added per flask.

Hydrolysis of the protein and chromatographic isolation of the serine accounted for approximately 50 per cent of the incorporated radioactivity in all cases; previous studies have shown that methionine also contains a large portion of the radioactivity.

Whether or not this œstrogen-like action of the 2- and 4-hydroxy œstradiols *in vitro* is mediated in the same manner as the *in vivo* stimulation of this system by œstradiol remains to be determined. In any event it appears useful as a tool in duplicating *in vitro* conditions within the tissue achieved by *in vivo* action of the natural hormone.

I thank Mrs. Grace Bowman for valuable technical assistance throughout this work, which was supported by grants from the Alexander and Margaret Stewart Trust, the U.S. Public Health Service (1897-*C*2) and the American Cancer Society.

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Feb. 18.

[1] Robinson, J. R., *Biochem. J.*, **45**, 68 (1949).
[2] LePage, G. A., *Cancer Research*, **13**, 178 (1953).

Germanium in Some of the Waste-Products from Coal

It is well known that many of the trace elements of coal are enriched in certain of the waste products, such as flue dusts, resulting from the utilization of the coal. Crawley[1], and Forrest, Smith and Ward[2] have recently commented on the value of products of this type as raw materials for the recovery of germanium. In the course of work on the behaviour of germanium and other trace elements during the utilization of coal, we have obtained results suggesting conclusions rather different from some of the concepts implied in the note of Forrest *et al.*

Samples of residual ash from the grates of stoker-fired boilers have been found to contain only relatively small quantities of germanium, ranging from less than 1 p.p.m. to about 12 p.p.m., with a mean value of about 3 p.p.m. On the other hand, coal samples similar to those being burnt in power stations have been ashed under laboratory conditions where no appreciable loss of germanium occurs, and the mean germanium content of these ashes is much greater—of the order of 50 p.p.m. It thus appears that during the combustion of coal in stoker-fired boilers, the greater part of the element is volatilized from the fuel bed. The problem of obtaining germanium-rich material from such a combustion therefore seems to be not so much the difficulty of volatilizing the element, as the means of collecting the volatilized element at a sufficiently high concentration.

Our results also suggest that germanium is more likely to be incorporated in external boiler deposits and flue dusts by the collection, or trapping, of very small germanium-rich particles than by the condensation *in situ* of a volatile compound. For example, analyses of some hundred samples of external deposits and flue dusts have shown no evidence of any consistent fractionation of germanium with respect to the general position of the deposit in the boiler system (see Table 1).

There is a tendency for deposits from the upper deck of steam-generating tubes to furnish a somewhat richer material; but, on average, the deposits from all regions in the flue system exhibit the same order of enrichment of germanium. The frequency-

Table 1. Average Enrichment of Germanium in Deposits from Various Zones of a Power-Station Boiler

Zone	Enrichment factor (relative to coal ash)	Average germanium content (per cent)
Lower deck steam-generating tubes	10	$0{\cdot}05_2$
Superheater tubes	10	$0{\cdot}05_7$
Upper deck steam-generating tubes	20	$0{\cdot}1_3$
Economizers	10	$0{\cdot}06_3$
Air heaters	10	$0{\cdot}04_8$

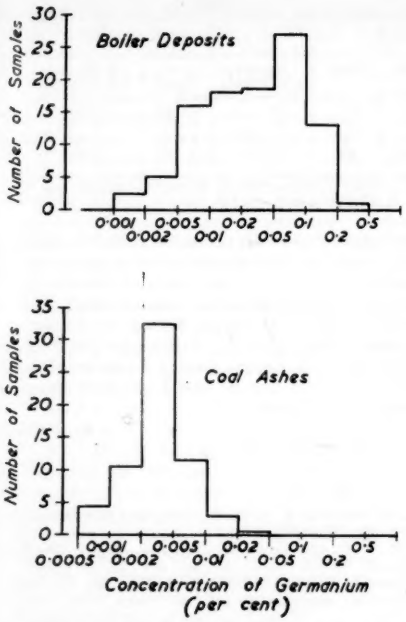

Fig. 1. Frequency-distribution of germanium concentrations in power-station boiler deposits and in coal ash

distribution of the concentration values for these hundred deposits compared with that for laboratory-prepared ashes from commercial grades of coal shows a similar effect; histograms for these two types of material are shown in Fig. 1, and indicate that practically all the deposit samples show enrichment of their germanium contents, the most frequently occurring, lower, values for coal ash being virtually unrepresented in deposits. Incorporation of germanium in deposits does not seem, therefore, to be markedly selective, and hence is more likely to consist of a physical trapping of solid particles than a temperature-dependent condensation directly into the deposit.

More evidence on this point has been obtained in the examination of dusts taken from the waste-gas flues of the built-in producers used for heating coal-carbonization plant. It may fairly be assumed that a similar mechanism of transfer of germanium operates in such plant, although the two cases differ in that gas velocities are higher in boiler plant than in built-in producer plant. It has been found that the very fine dust suspended in the chimney gases of a built-in gas-works producer can contain up to 2 per cent of germanium, and that this represents an appreciable proportion of the germanium originally present in the fuel. The presence of a germanium-rich suspension, or smoke, in the flue gases resulting from the high-temperature oxidation of coke appears, therefore, to be established. A similar condition can be inferred for stoker-fired furnaces.

It is possible that in power-station boilers the higher rate of gas-flow would decrease the chance of this fine material being deposited on the flue surfaces, and that the proportions of germanium lost to the atmosphere would be correspondingly greater than occurs in gas-works producers. Some of our results support this possibility; but the question is being investigated further. This consideration, however, is not likely to be the only reason for the lower concentrations encountered in power-station boiler deposits, as compared with deposits from the waste-gas flues of producer-gas plant. At the Fuel Research Station, maximum concentrations of 0·2 and 3 per cent respectively have been noted for these two types of material. Such differences may be due, in part at least, to different degrees of dilution of germanium by inert fly-ash particles: the higher gas velocity in the power-station boiler might be important in this respect also, by causing a greater deposition of larger ash particles which would of necessity have a relatively high diluting capacity.

This work forms part of the programme of the Fuel Research Board of the Department of Scientific and Industrial Research and is published by permission of the Director of Fuel Research.

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Abnormal Freezing Nuclei in the Atmosphere

Freezing nuclei in the atmosphere are characterized by a critical threshold temperature below which, and only below which, they initiate the freezing of water droplets with which they may be associated. I have devised a simple method of testing whether or not there is at least one freezing nucleus in a given sample of air (about 200 c.c.) which is active at any given temperature; it is similar to that described by me in 1947 [1], except that expansions are performed more slowly (lasting about 1 sec., and allowing droplet growth to follow the cooling).

During the past ten years, a very large number of measurements have been made with a similar apparatus in many parts of the world. The general result is that there are few nuclei which have a threshold temperature above − 32° C., but there are a fairly large number of nuclei which are active at this temperature or a little below.

In the winter of 1954–55, similar measurements were carried out in Panama. During the first six weeks these measurements indicated rather few nuclei and those with threshold temperatures about − 32° C. or little lower as found elsewhere. On January 13 a very large number of nuclei (more than 10^5/m.^{3}) were suddenly found, and these with threshold temperatures as high as − 18° C. Such abundant freezing nuclei, active at this temperature, had never been observed before. These nuclei were continuously present until January 18, when nuclei with a threshold temperature of − 13° C. were found. These nuclei were present for another day, after which the threshold temperature gradually dropped to − 17° C. on January 30, and then there was a secondary maximum with nuclei present having a threshold of − 15° C. Thereafter the threshold gradually decreased until the normal value of − 32° C. was reached on February 17.

Experiments showed that the abnormal nuclei were large, since they were easily stopped by a short cotton-wool filter.

The appearance of the unusual nuclei was accompanied by prolonged, continuous rain, which is abnormal in these latitudes at this season. On January 14 the rain changed to showers; but heavy rain fell on January 17 and 18. The secondary maximum on January 30 was accompanied by many thunderstorms, after which the rains gradually died out.

Aircraft observations indicated that some of these rains were of 'warm' type; thus it appears that though the nuclei have been detected due to their exceptional freezing ability, they can also serve as efficient warm rain nuclei.

At first it was suspected that the abnormal nuclei were residues from the hydrogen bomb explosions, and the results were communicated privately to a number of scientific centres. As a result, Vincent J. Shaefer and Dr. E. G. Bowen reported that they had also found exceptionally heavy ice nucleation on Mount Washington and in Australia respectively on January 13. This apparent world-wide increase in nuclei agrees strikingly with the dates expected from Bowen's[3] meteoritic hypothesis and would seem to confirm it.

It would seem most desirable that regular measurements of ice nuclei having various threshold temperatures and of condensation nuclei should be made at a number of observatories widely distributed over the world, in view of their importance if Bowen's hypothesis is found to be correct.

Note added in proof. On May 23, 1955, nuclei with the threshold −13° C. were observed again and were present for two days. These nuclei correspond to the meteoric shower of Lyrids (April 21).

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Panama. May 3.

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Isotope Shifts in the Spectrum of Helium

Experiments on various line series in helium[1,2] show that Hughes and Eckart's treatment[3] of the 'specific' isotope shift in this case is inadequate. Their wave functions take no account of configuration interaction, to which the specific effect is very sensitive.

The specific shifts of the 2^1S, 2^3S terms of helium have now been calculated in the usual first-order perturbation treatment, using the wave functions of Hylleraas and Undheim[4] and Huang[5]. These wave functions include configuration interaction in an adequate manner. The constants for the Hylleraas–Undheim triplet function were kindly supplied by Prof. E. A. Hylleraas. The coefficients in their singlet function were calculated from the original data.

The results of the calculations are compared with experiment in Table 1. Some approximations were made in the calculation with the Huang triplet function; but it is estimated that the specific shift is accurate to the two significant figures given in the table. The results disagree with those found by Hamermesh and Eisner using the Huang wave functions and quoted by Fred *et al.*[1]. The experimental values are taken from Bradley and Kuhn[2], who estimated the term shifts by extrapolating the observed shifts of lines $2S—nP$ to the series limits. Fred *et al.*[1] found a residual shift of about 0·135 cm.$^{-1}$ for the 2^1S state, which agrees well with the value 0·13 cm.$^{-1}$ given by Bradley and Kuhn.

Table 1

Shift	Term	Wave function: Hughes and Eckart	Wave function: Huang	Wave function: Hylleraas and Undheim	Exp.
A	2^1S	0	0·159	0·149	0·13
A	2^3S	0	0·076	0·0758	0·10
B	2^1S	1·436	1·595	1·585	1·57
B	2^3S	1·723	1·799	1·799	1·82

A = total term-shift minus normal term-shift (cm.$^{-1}$).
B = total term-shift (cm.$^{-1}$).

The total term-shifts obtained from the calculations are all close to the experimental values. It is concluded that nuclear motion makes by far the most important contribution to isotope shift in helium. Further details will be published elsewhere.

I wish to thank Dr. H. Kuhn and Dr. J. A. Spiers for their interest in this work. I am indebted to the Department of Scientific and Industrial Research for a maintenance grant.

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May 16.

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Time Interval between Nucleogenesis and the Formation of Meteorites

While determining the radiogenic argon-40 content of the Beardsley chondritic meteorite[1], a mass spectrometric search for xenon-129 produced by decay of iodine-129 was made. The total amount of xenon which was observed was 5×10^{-9} c.c. (s.t.p.) from a 29·86-gm. meteorite sample. Within the limits of experimental error, this xenon had a normal isotopic composition[2]. The ratio of xenon to argon-36 was in essential agreement with that found in air, indicating that this xenon was due to atmospheric contamination. Since a 30 per cent increase in the abundance of xenon-129 over that observed in normal xenon would have been observable, this indicates that radiogenic xenon-129 was present in this meteorite to less than $1{\cdot}3 \times 10^{-11}$ c.c. (s.t.p.)/gm. H. E. Suess and M. G. Inghram (personal communication) have suggested that if the meteorites had been formed soon after the formation of the elements, they would contain an excess of xenon-129 due to decay of iodine-129.

A lower limit for the time-interval t between the formation of the elements and the last crystallization of the meteorites may be calculated by assuming that iodine-129 and iodine-127 were originally made in equal abundance, and that there has been no loss of xenon due to diffusion since the meteorite was last crystallized. The iodine-127 content is taken to be 1 p.p.m. by weight, based on the values reported by Fellenberg[3] for other stony meteorites. The equation for t is

$$t = \frac{T_{1/2}}{0{\cdot}693} \ln \frac{^{129}\mathrm{I}}{^{129}\mathrm{Xe}}$$

where $T_{1/2}$ is the half-life of iodine-129, ^{129}I is the amount of iodine-129 originally formed and ^{129}Xe is the amount of xenon-129 now present in the meteorite due to the decay of iodine-129.

From the limit of detectability presented above, one may conclude that $t/T_{1/2} \geqslant 23{\cdot}7$. Using the value[4] of $1{\cdot}7 \times 10^7$ yr. for $T_{1/2}$, we obtain $t \geqslant 0{\cdot}41 \times 10^9$ yr. I. Noddack and W. Noddack reported a value of $3{\cdot}5 \times 10^{-3}$ p.p.m. by weight of iodine in meteorites[5]. This value is considerably lower than that reported by Fellenberg. It is very doubtful whether the iodine content of meteorites is any lower than the value of $3{\cdot}5 \times 10^{-3}$ p.p.m. reported by the Noddacks. Using this lower value, we obtain $t/T_{1/2} \geqslant 17{\cdot}4$. It is clear that this calculation is very insensitive to such a change in the iodine abundance. The critical effect is, of course, that of xenon diffusion. H. C. Urey (personal communication) has pointed out that the iodine in stony meteorites may be bound on the surfaces of the mineral grains, and hence, the loss of xenon by diffusion might be greatly facilitated. This effect would cause the calculated lower limit for t to be too large.

The ^{40}A—^{40}K age reported for the Beardsley meteorite is $4{\cdot}8 \pm 0{\cdot}2 \times 10^9$ yr.[1]; thus, a lower limit of $5{\cdot}0 \times 10^9$ yr. for the time since the formation of the elements is obtained.

If the assumptions mentioned above are valid, and if the Earth and the meteorites are cogenetic, all the radioactive elements with half-lives short compared to 4×10^8 yr. would have decayed in the time interval between nucleogenesis and the formation of the Earth and would, therefore, not contribute to the heating of the primeval Earth.

We thank Prof. M. G. Inghram and Prof. H. C. Urey for several stimulating discussions. This work was performed in part under the auspices of the U.S. Atomic Energy Commission.

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Feb. 18.

[1] Wasserburg, G., and Hayden, R., *Phys. Rev.*, **97**, 86 (1955).
[2] Nier, A., *Phys. Rev.*, **79**, 450 (1950).
[3] Von Fellenberg, Th., *Biochemische Z.*, **187**, 4 (1927).
[4] Katcoff, S., Schaeffer, O., and Hastings, J., *Phys. Rev.*, **82**, 688 (1951).
[5] Noddack, I., and Noddack, W., *Svensk Kem. Tid.*, **46**, 173 (1934).

Distribution-in-Speed of Fading of 150-kc./s. Waves

A considerable amount of work has been done on the 'speed of fading' of radio waves[1–3]. This quantity, often referred to as v_τ, denotes the change in the amplitude in a certain time, τ, expressed as a fraction of the root mean square amplitude of the wave. The first-order theory indicates that the distribution-in-speed should be a normal one representable by:

$$p(v_\tau) = \frac{\exp(-v_\tau^2/4\varepsilon)}{\sqrt{4\pi\varepsilon}}$$

It has, however, been pointed out[4,5] that, if the lag τ used for the computation of v_τ be large, the first-order theory breaks down and the distribution assumes a form:

$$p(v_\tau) = \frac{\exp(-v_\tau^2/4\varepsilon)}{\sqrt{4\pi\varepsilon}}\,\varphi(\varepsilon, v_\tau)$$

where φ is a monotonically decreasing function of v_τ, the rate of decrease depending on the parameter ε. This leads to a distribution narrower than normal, which we will denote as the modified Gaussian distribution.

The value of the lag τ for which the breakdown becomes appreciable is greater the smaller the frequency of the radio wave. Hence it can be expected that the deviation from the normal form of the distribution will be evident more readily at higher frequencies than at lower frequencies.

Workers at Cambridge[2,3], using short waves, found distributions significantly narrower than normal. An extension of the analysis to lower frequencies has been made by us at the Pennsylvania State University, using the fading of 150 kc./s. waves. The slow rate of fading of these waves made it necessary for us to use much larger time lags than those used by the Cambridge School. However, no significant deviation from normality has been found. Fig. 1 indicates a typical distribution-in-speed. We have superposed the corresponding normal and modified Gaussian distributions on the histogram. It will be seen how the histogram is statistically indistinguishable from the normal. Also, the expected theoretical deviation is so small that a statistical distinction would not be possible. This seems to bear out the previous prediction that the similarity to the normal distribution would be more pronounced with long waves than with short waves.

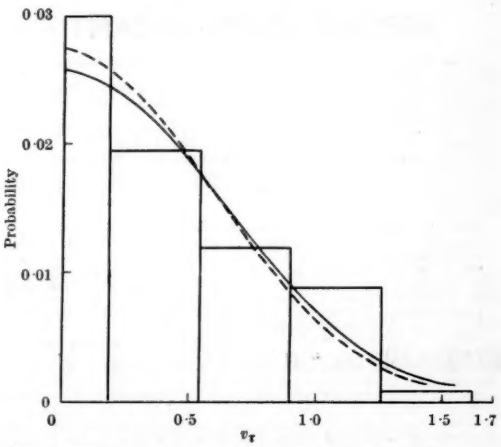

Fig. 1. Histogram for speed of fading with a lag of 20 sec. on March 8, 1952, at 0000. The normal distribution with $\varepsilon = 0{\cdot}19$ is shown superposed as a solid line. The dotted line shows the modified Gaussian distribution

This work was carried out with the support and sponsorship of the Geophysical Research Directorate of the Air Force Cambridge Research Center, Air Research and Development Command, under Contract *AF*19(122)-44.

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Jan. 8.

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FORTHCOMING EVENTS

Sunday, July 17—Friday, July 22

University of London (at Wye College, near Ashford, Kent)—Third International Conference on "Plant Growth Substances".

Monday, July 18—Saturday, July 23

International Association of Applied Psychology (in the Beveridge Hall of the Senate House of the University of London, and Birkbeck College, Malet Street, London, W.C.1)—12th Congress.

Tuesday, July 19—Friday, July 22

Association of Applied Biologists (at Oxford)—Summer Meeting.

Thursday, July 21

Royal Society of Tropical Medicine and Hygiene (at the Hospital for Tropical Diseases, 4 St. Pancras Way, London, N.W.1), at 7.30 p.m.—Clinical Meeting. Chairman: Prof. R. M. Gordon, O.B.E.

Thursday, July 21—Saturday, July 23

Royal Meteorological Society (at Ashburne Hall, University of Manchester, Fallowfield, Manchester)—Symposia on "Some Aspects of Turbulence in the Atmosphere" and "Oceanographic Topics".

Saturday, July 23

Association of Clinical Biochemists, Southern Region (at the Central Laboratory, Milton Road, Portsmouth), at 11 a.m.—Scientific Papers and Demonstrations.

Saturday, July 23—Sunday, July 24

British Psychological Society, Northern Branch (at the University College of North Staffordshire, Keele, Stoke-on-Trent, Staffs)—Scientific Papers.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Chemistry at the College of Further Education, Grimsby—The Director of Education, Education Office, Eleanor Street, Grimsby (July 23).

Tutorial Student in Theoretical Physics—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (July 23).

Lecturers (2) in Electrical Engineering—The Secretary of University Court, The University, Glasgow (July 25).

Assistant Lecturer or Lecturer (with qualifications in physical and inorganic chemistry) in Chemistry—The Registrar, The University, Hull (July 30).

Assistant (preferably with qualifications in physical geography) in Geography—Joint Clerk to the University Court, Queen's College, Dundee (July 30).

Chair of Mathematics at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education Overseas, 1 Gordon Square, London, W.C.1 (July 30).

Lecturer or Assistant Lecturer in Botany—The Registrar, The University, Birmingham (July 30).

Scientific Officer (with a first- or second-class honours degree in engineering or applied science with a knowledge of soil mechanics, or equivalent qualifications) at the Road Research Laboratory (D.S.I.R.), Harmondsworth, Middlesex, to act as Assistant to the Colonial Road Research Liaison Officer, and visit Colonial territories to assess road problems suitable for research, advise on road works, disseminate information and answer inquiries, and undertake research into problems relating to Colonial roads—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting E.373/5/A (July 30).

Assistant Professor or Professor in Mathematics, and an Assistant Professor in Physics, at the Higher Teachers' College, Baghdad, Iraq—The Cultural Attaché, Iraqi Embassy, 22 Queen's Gate, London, S.W.7 (July 31).

Lecturer or Assistant Lecturer in Mathematical Statistics in the Department of Applied Mathematics—The Registrar, The University, Liverpool (August 8).

Lecturer (with a university degree or equivalent qualification, and preferably some teaching and industrial experience) at the Ministry of Supply School of Electronics, to teach electronics and mathematics to H.N.C. standard—The Principal, School of Electronics (Ministry of Supply), Malvern, Worcs (August 8).

Research Assistant (with experience in practical microscopy) in the Department of Metallurgy—The Registrar, The University, Manchester (August 8).

Lecturer in Education at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (New Zealand, August 12).

Lecturer (with qualifications in chemistry or biochemistry and a wide experience in the biochemistry of steroids) in Pathological Biochemistry at the Royal Infirmary—Secretary of University Court, The University, Glasgow (August 13).

Lecturer in Applied Mathematics at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 15).

Senior Lecturer in Zoology at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, August 15).

Lecturer (preferably with special qualifications in micro- and semi-micro analytical techniques) in Chemistry—The Secretary, The University, Aberdeen (August 20).

Lecturer (with special qualifications in physical chemistry) in Chemistry—The Secretary, The University, Aberdeen (August 20).

Lecturer in Philosophy at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, September 5).

Deputy Director (with high academic qualifications and research experience in one or more of the cognate sciences: biochemistry, chemistry or pedology, together with administrative ability)—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen (September 15).

Chemist (with at least H.S.C. in science subjects, or equivalent qualifications, and preferably experience with thermal diffusion, R.F. heaters and radioactive gases), to work in gas handling with high vacuum apparatus—Establishment Officer, United Kingdom Atomic Energy Authority, Atomic Energy Research Establishment, Harwell, Didcot, Berks, quoting 2/103/353.

Demonstrator (with qualifications in bacteriology and an interest in the physiology of bacteria) in the Department of Botany—The Registrar, The University, Nottingham.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

No Man is an Iland: a Re-statement of an Historic Testimony Against War. By Reginald A. Smith. Pp. 7. (London: Friends Peace Committee.) 4*d*. [245

Department of Scientific and Industrial Research. Report of the Pest Infestation Research Board, with the Report of the Director of Pest Infestation Research for the year 1954. Pp. iv+54+4 plates. (London: H.M. Stationery Office, 1955.) 3*s*. net. [275

Ministry of Agriculture and Fisheries. Bulletin No. 149: Farm Grain Drying and Storage. Pp. iv+121+12 plates. (London: H.M. Stationery Office, 1954.) 5*s*. net. [275

British Coal Utilisation Research Association. Annual Report, 1954. Pp. 66+4 plates. (Leatherhead: British Coal Utilisation Research Association, 1955.) [275

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